Seaplane Course (Airplane Single-Engine Sea)

Course Objectives

The course objective is to provide the student with the knowledge, skills, and aeronautical experience necessary to safely function as pilot-in-command in a single-engine sea airplane.

Course Completion Standards

The student will demonstrate through oral examinations and flight test that he/she meets the knowledge, skills, and experience required to safely function as pilot-in-command of a single-engine sea airplane.

Enrollment Requirements

The student is required to have, at the time he/she is enrolled in the training course, the following:

1. At least a Private Pilot-Single Engine Land certificate.
2. Hold a valid Medical Certificate.
3. Be able to read, speak, and understand the English language.

Graduation Requirements

To complete the SES Course the student must:
1. Meet the enrollment requirements.
2. Complete the flight and ground school lessons.
3. Pass the flight check

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Ground Lesson 1

Objectives

During this lesson the student will gain an understanding of float installation, attachment hardware, nomenclature of parts and their functions, and design of floats along with float plane safety.

Content

1. Float Installation
2. Attachment Hardware
3. Nomenclature of Float Parts
4. How Floats Work
5. Float-plane Safety

References

1. Float-plane Video
2. Printed Material
   A. Seaplane Operations Handbook, FAA-H-8083-23
   B. Excerpted from (old)FAA Flight Training Handbook AC 61-21A

Completion Standards

During class session the ground instructor will determine that the student understands float installation, attachment hardware, nomenclature of parts and their functions, and design of floats along with float plane safety.

Ground Lesson 2

Objectives

During this lesson the student will gain an understanding of the contents of the aircraft flight manual including the applicable supplements specific to the aircraft being flown.

Content

1. General - Airplane & Systems
2. Limitations
3. Emergency Procedures
4. Normal Procedures and Checklist Usage
5. Performance
6. Weight & Balance
7. float plane Supplement

References

1. Airplane Flight Manual (excerpts)
2. Float plane Supplement (excerpts)
3. Float plane Normal Checklist

Completion Standards

During class session the ground instructor will determine that the student understands the contents of the aircraft flight manual including the applicable supplements specific to the aircraft being flown.

Ground Lesson 3

Objectives

During this lesson the student will gain an understanding of the preflight inspection of a seaplane, starting and departing the shore or ramp along with the procedures and rules of taxiing.

Content

1. Preflight Inspection
2. Launching or Push-back
3. Starting Out
4. Taxing
   A. Displacement
   B. Step
5. Turns
   A. Displacement
   B. Plowing
   C. Inertia
   D. Step
6. Right of Way Rules: Water Operations

References

1. All Previous References

Completion Standards

During class session the ground instructor will determine that the student understands the preflight inspection of a seaplane, starting and departing the shore or ramp, along with the procedures and rules of taxing.

Ground Lesson 4

Objectives

During this lesson the student will gain an understanding of normal and crosswind takeoffs and landings, cruise flight operations and maneuvering.

Content

1. Takeoffs
    - A. Normal
    - B. Crosswind
    - C. Glassy water
    - D. Rough Water
    - E. Maximum Performance
2. Flying the float-plane
    - A. Performance
    - B. Stability
3. Landing Area Assessment
4. Landings
    - A. Normal
    - B. Crosswind
    - C. Glassy Water
    - D. Rough Water
    - E. Maximum Performance

References

1. All Previous References

Completion Standards

During class session the ground instructor will determine that the student understands normal, crosswind, glassy water, rough water and max performance takeoffs and landing and climb and cruise flight performance.

Ground Lesson 5

Objectives

During this lesson the student will gain an understanding of ramping, docking, mooring, beaching, approaching a buoy and sailing.

Content

1. Ramping
2. Docking
3. Mooring
4. Beaching
5. Approaching a buoy
6. Sailing
    A. Power Off
    B. Power On

References

1. All Previous References

Completion Standards

During class session the ground instructor will determine that the student understands ramping, docking, mooring, beaching, approaching a buoy, and sailing.

Flight Lesson 1

Objectives

The student will be introduced to basic flight maneuvers while operating a seaplane.

Content

1. Preflight discussion of all maneuvers to be performed
2. Introduction
    - A. Preflight inspection
    - B. Start and Taxi on Water
    - C. Normal Takeoffs and Climb out
    - D. Constant Altitude Turns
    - E. Stall Recognition and Recovery Procedures
        1. Power Off
        2. Power On
    - F. Maneuvering at Critically Slow Airspeed
    - G. System and Equipment Malfunctions
    - H. Landing Area Assessment
    - I. Normal Approach and Landing
3. Post-flight Discussion

References (for all Flight Lessons)

1. All Previous References
2. Applicable Practical Test Standards

Completion Standards

The student will display an understanding of the maneuvers and procedures introduced. The students performance will meet the standards outlined in the Practical Test Standards.

Flight Lesson 2

Objectives

The student shall review previously learned maneuvers and procedures to develop understanding and proficiency. In addition, he/she shall be introduced to water emergencies, determining wind and water conditions, taxiing, normal and rough water takeoffs, normal and rough water landings, go arounds, and emergency landings.

Content

Preflight Discussion

Review

A. Preflight Inspection
B. Start and Taxi on Water
C. Normal Takeoffs and Landings
D. Constant Altitude Turns
E. Stall Recognition & Recovery Procedures
F. Slow Flight
G. System & Equipment Malfunctions
H. Landing Area Assessment

Introduction

A. Water Emergencies & Use of Equipment
B. Taxiing
    1. Displacement (Idle) Taxi & Effects of Wind
    2. Step Taxi & Positioning of Controls
C. Rough Water Takeoffs & Landings
D. Go Arounds
E. Emergency Approach & Landing

Post-flight Discussion

Completion Standards

The student will demonstrate an increased understanding and proficiency in previously learned maneuvers and procedures. The student will also demonstrate a basic understanding of new maneuvers and procedures introduced.

Flight Lesson 3

Objectives

The student shall review previously learned maneuvers and procedures to develop understanding and proficiency. In addition he/she shall be introduced to crosswind takeoffs and landings, plow and step turns, and glassy water takeoffs and landings.

Content

1. Preflight Discussion
2. Review
    - A. Taxiing
        1. Displacement (Idle)
        2. Step
    - B. Rough Water Takeoffs and Landings
    - C. Emergencies, including Go Arounds
3. Introduction
    - A. Crosswind Takeoffs and Landings
    - B. Turns
        1. Plow
        2. Step
    - C. Glassy Water Takeoffs & Landings
4. Post-flight Discussion

Completion Standards

The student will demonstrate an increased understanding and proficiency in previously learned maneuvers and procedures. The student will also demonstrate a basic understanding of new maneuvers and procedures introduced.

Flight Lesson 4

Objectives

The student shall review previously learned maneuvers and procedures to develop understanding and proficiency. In addition he/she shall be introduced to sailing, mooring, docking, ramping, beaching, approaching a buoy, and maximum performance takeoffs and landings.

Content

1. Preflight Discussion
2. Review
    - A. Crosswind Takeoffs and Landings
    - B. Turns
        1. plow
        2. Step
    - C. Glassy Water Takeoffs & Landings
3. Introduction
    - A. Sailing
    - B. Mooring
    - C. Ramping
    - D. Docking
    - E. Beaching
    - F. Approaching a Buoy
    - G. Maximum Performance Takeoffs and Landings
4. Post-flight discussion

Completion Standards

The student will demonstrate an increased understanding and proficiency in previously learned maneuvers and procedures. The student will also demonstrate a basic understanding of new maneuvers and procedures introduced.

Flight Lesson 5

Objectives

This lesson is a final review of all previously learned maneuvers and procedures. The student's readiness for the seaplane rating check flight will be evaluated, and all areas reviewed as necessary.

Content

1. Preflight Discussion
2. Review
    A. Step turns
    B. Glassy Water landings
    C. Docking
    D. Selected maneuvers & Procedures which the instructor feels necessary for review.
3. Post-flight Discussion

Completion Standards

The student will demonstrate an increased understanding and proficiency in the items done for review. These maneuvers shall prepare the student for the check-flight and will beet standards outlined in the Practical Test Standards for a Single Engine Sea Rating.

Flight 6 Seaplane Check flight

Objective

The student will perform all maneuvers and procedures as required in the Practical Test Standards for Airplane Single Engine Sea Rating.

Content

1. Preflight Discussion/Oral Test
2. Flight Check by examiner.
3. Post-flight Discussion
    A. Joining the Seaplane Pilot's Association
        1. North Texas Seaplanes, will pay for 1/2 of the new seaplane pilot's first year's dues.

Completion Standards

The student will be able to perform all assigned maneuvers with smoothness and accuracy to meet the standards outlined in the Practical Test Standards for the issuance of an Airplane Single Engine Sea rating.

Single Engine Sea Study Notes

1. Taxiing on the Water
2. Traffic Pattern
3. Rough Water Operations
4. Glassy Water Operations
5. Docking
6. Power-off Sailing

1. Taxiing on the Water

There are three types of water taxis we use with a float-plane.

1. Idle Taxi
2. Plow Taxi
3. Step Taxi

The float-plane stays afloat in idle and plow taxi due to the floats' buoyancy. The float-plane stays afloat in step taxi due to planing action (like water skis).

The checklist we use prior to idle, plow, or step taxi and take-off, landing, or sailing is the acronym "F.A.R.T.S."

F. Flaps and Flight Controls Checked
A. Area Clear
R. Water Rudder Up (or Down)
T. Trim Set
S. Stick Aft (or Forward)

The characteristics of the three water taxi types are summarized in the table below:

Type of Taxi	Flaps	Area	Water Rudders	Trim	Stick	Power	Ailerons
Idle	Zero	Clear	Down	Set	Aft or Fwd as Req'd	1000 RPM	Head Into Wind Tail Away from Wind
Plow	Zero	Clear	Down	Set	Aft	Full Power then 1700 RPM	Head Into Wind Tail Away from Wind
Step	Zero	Clear	Up	Set	Aft then as Required	Full Power and then about 2000 RPM	Required to keep wings level usually into Turn

Idle Taxi is generally considered to be the best form of taxiing because we have:

1. Good visibility
2. Good cooling
3. No spray problem

Plow Taxi is generally considered to be the least desirable form of taxiing because we have:

1. Bad visibility
2. Bad cooling
3. Potential spray problem

We use Plow Taxi Turn to turn from upwind to downwind when the wind is to strong to do so in Idle Taxi, when we need good control in confined maneuvering space, and/or for training purposes.

Plow Taxi Turn is accomplished as follows: (after F.A.R.T.S. checklist)

1. With engine idling, directly into the wind and water rudders down, use right rudder and left aileron into the wind, to cause the float-plane to turn right 15-20 degrees.
2. Continuing to hold aileron into the wind, reverse the turn by pushing full left rudder. As the float-plane nose passes through the wind begin partial power application for nose-up attitude, while holding full back stick, full left rudder, and aileron into the wind.
3. When established in the turn, reduce power slightly, while continuing to hold nose high. When established downwind, neutralize rudders and ailerons, and reduce power to idle. Hold forward stick in strong winds, or with tailing swells.

Step Taxi is used to travel long distances in a short time when the wind and waves are sufficiently calm to do so without banging the floats and fuselage too much. During Step Taxi we have :

1. Good visibility
2. Fairly good cooling
3. No spray problem

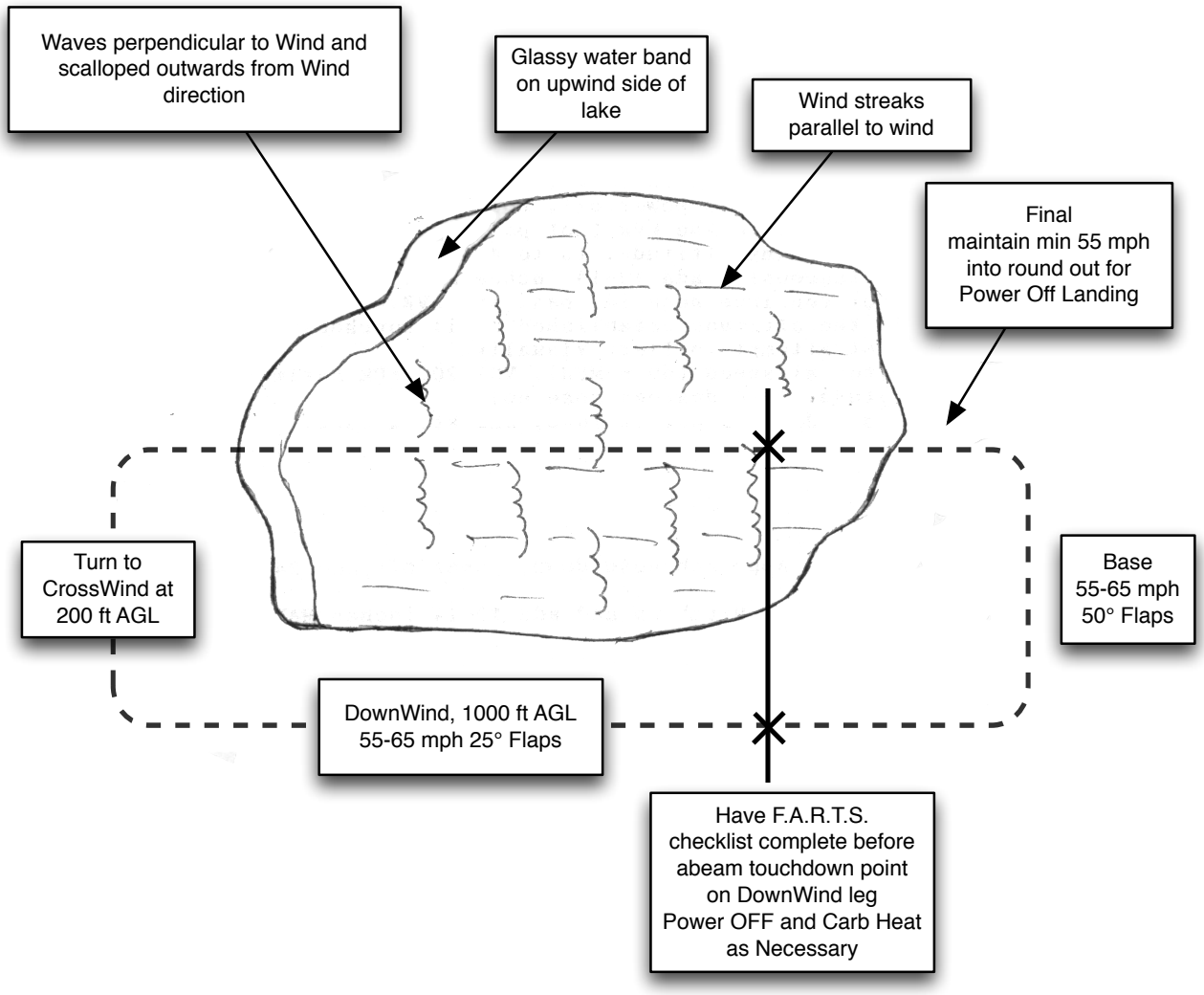
Step Taxi is accomplished as follows: (after F.A.R.T.S. checklist)

1. Point float-plane directly upwind or downwind
2. Add full power, full aft stick
3. When the nose has reached its highest point, start smoothly releasing back pressure on the stick, to allow the seaplane to accelerate onto the step. Then, adjust power to stay on the step, as per the table on the previous page. About 1900-2100 RPM, gps ground speed will be 30-35 knots.
4. Do not taxi any faster than necessary to stay on the step without porpoising.
5. Continue to make small stick and throttle corrections so as to maintain the float-plane on the step.

2. Traffic Pattern

Choose the longest runway on the water consistent with the wind direction. On landing, flare to minimum safe attitude (like the step taxi attitude, one ball nose up) when the bottoms of the floats are about 10 feet above the water. Do Not Touch Down in a Nose Low Attitude!!

Normal TakeOff is similar to Step Taxi, except full power is left on and as the float-plane accelerates on the step very slight back pressure is applied to hold the floats in the "sweet spot" until airborne.


Waves perpendicular to Wind and scalloped outwards from Wind direction
Glassy water band on upwind side of lake
Wind streaks parallel to wind
Final
maintain min 55 mph into round out for Power Off Landing
Turn to CrossWind at 200 ft AGL
Base
55-65 mph
50° Flaps
DownWind, 1000 ft AGL
55-65 mph 25° Flaps
Have F.A.R.T.S. checklist complete before abeam touchdown point on DownWind leg
Power OFF and Carb Heat as Necessary

3. Rough Water Operations:

TakeOff is the same as normal take-off except:

1. Use a slightly nose low attitude during the takeoff run (about 2 degrees lower to skim the tops of the waves without planting the bows in a wave).
2. Become airborne at minimum airspeed.
3. Use ground effect and accelerate to climb speed in normal climb attitude.

Landing is the same as normal landing except:

1. Set the power to 1200-1400 RPM after nose has come up during the 10 foot AGL flare.
2. Land at minimum airspeed, nose high on the back side a swell.
3. Power to idle and stick full aft on touchdown. Must avoid submerging the float tips in the next oncoming wave.

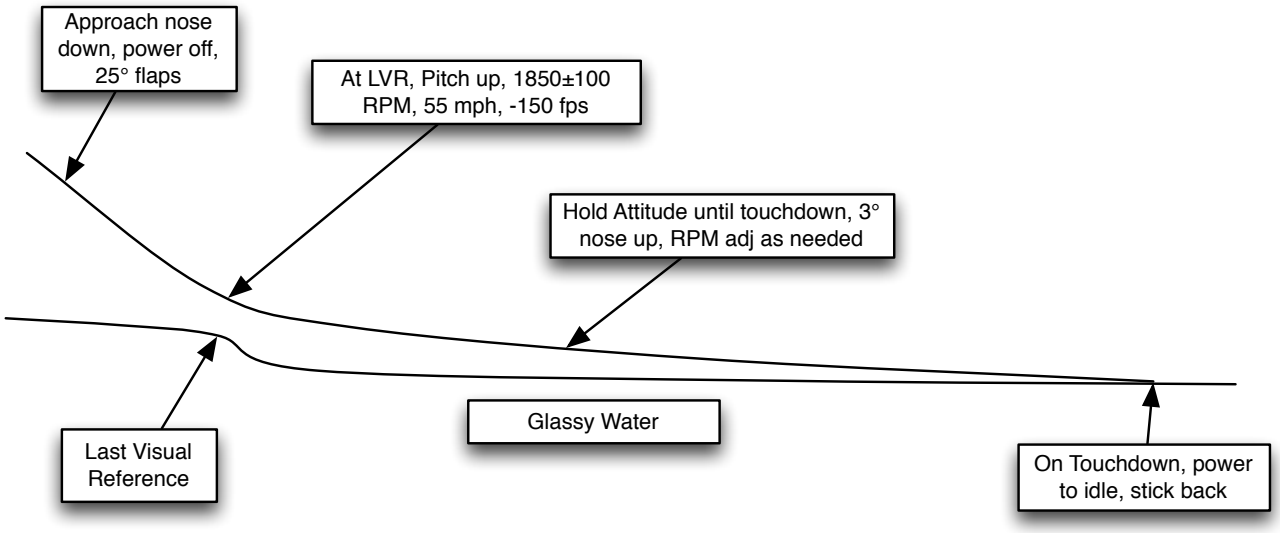
4. Glassy Water Operations

Take-off is the same as normal takeoff except:

1. Lift right float as take-off speed is approached(ailerons full left).
2. Rotate normally, (approximately 1 degree) and immediately level wings as right float lifts from the water.

Landing is the same as normal landing except:

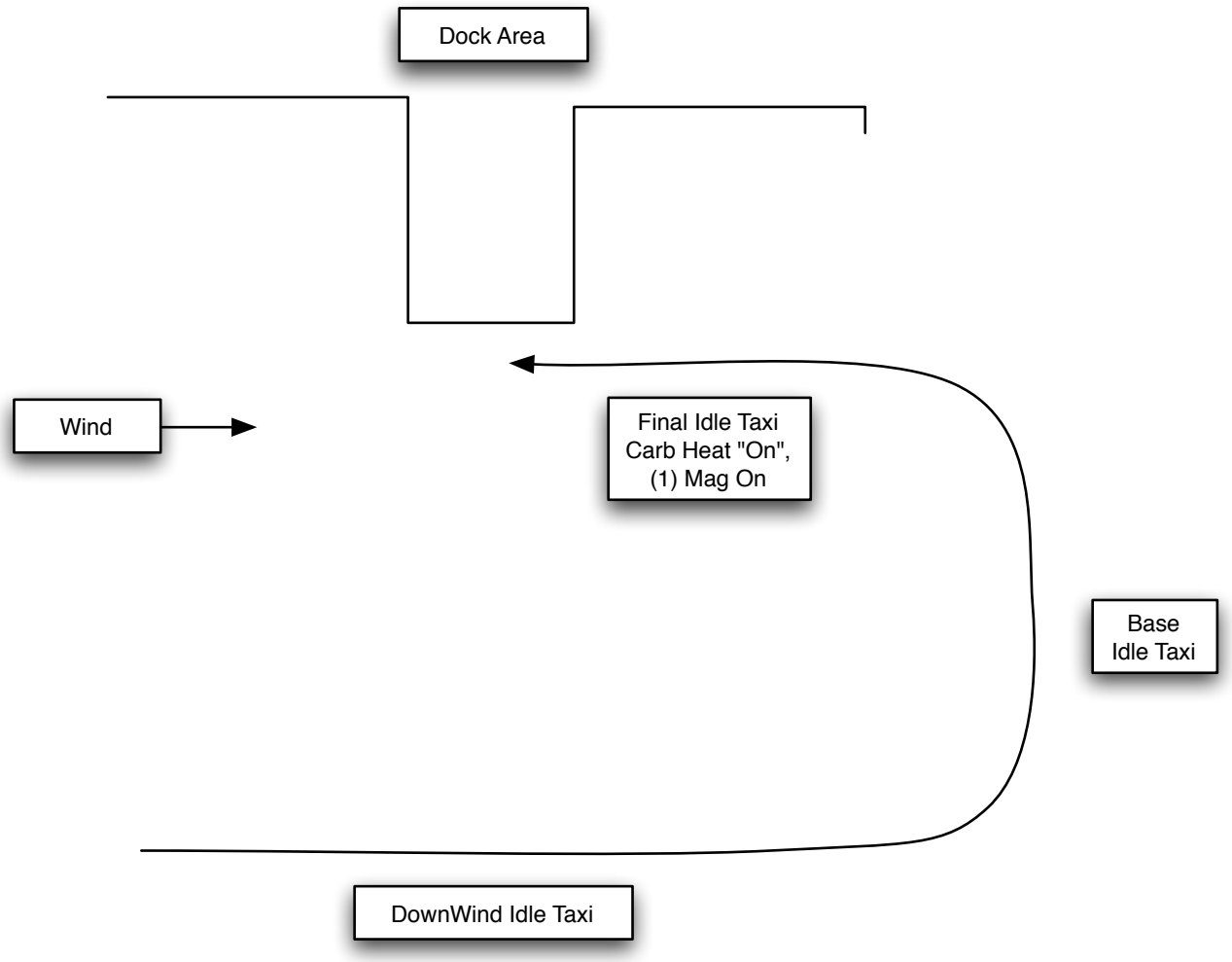
1. Choose a Last Visual Reference (LVR). Use 25 deg. flaps. (2nd notch)
2. Reduce power on downwind, opposite the LVR.
3. Maintain 55-65 MPH on base leg and final.
4. Approach the LVR power off, nose down.
5. Over or before the LVR (not past), establish the glassy water landing attitude. (3-4 degrees nose up,nose on horizon).
6. Simultaneously, set 1800±150 RPM, Prop Full RPM setting
7. do not continue nose low past the LVR.
8. Hold the attitude established until touchdown.
9. Do not attempt to flare visually.
10. Monitor airspeed (45-50 MPH), VSI -150 FPM Maximum, and attitude. (3-4 degrees nose up, nose on horizon) Trust from previous practice with airspeed 45-55 and power set to 1800 RPM and holding attitude correctly that aircraft will safely fly onto the water. Holding the correct attitude is of prime importance with airspeed secondary.
11. On touchdown, power to idle, and stick back, slowly, don't fly back off water.


Approach nose down, power off, 25° flaps
At LVR, Pitch up, 1850±100 RPM, 55 mph, -150 fps
Hold Attitude until touchdown, 3° nose up, RPM adj as needed
Last Visual Reference
Glassy Water
On Touchdown, power to idle, stick back

Alternate "Kenmore" glassy water technique: When the MSL altitude is known, descend to surface altitude + 100 feet, establish 45-55 mph and -150 down rate, this is useful in congested areas where you don't or can't make a low approach over a shoreline as for example Lake Washington in Seattle, hence the use of the "Kenmore" glassy water technique.

5. Docking

Dock into the wind after making a traffic pattern on the water. Use carb heat "on" and 1 magneto on final.



Note: A slower taxi speed can be achieved by running on a single mag and/or adding Carb Heat. Caution, if the docking is aborted and a takeoff is planned be sure and return the engine to BOTH mags.

6. Power-Off Sailing

Checklist: F. Flaps and Flight Controls - Set
A. Area - Clear
R. Rudder (water) - Up
T. Trim - Set
S. Stick - As Required

Directional Control:
Aileron - In the direction that you want to go, right(back), left(back)
Rudder - Opposite the ailerons.

7. Study Quiz

1. The best form of water taxi is?

2. The worst water taxi position is? Why

3. Which taxi turn is used in windy conditions? Why?

4. When making a step or plow turn, the turn that has the capability of capsizing a floatplane? Why?

5. The checklist we use in the PA-18 Super Cub Amphib before takeoff is?

6. The most dangerous condition for landing a floatplane is? Why?

7. What technique do we use for a glassy water takeoff?

8. What is it called when a floatplane turns into the wind at idle power?

9. Where should the stick be in idle and plow taxi?

10. Which form of taxi is used to cover long distances and save time?

11. What position should the water rudders be in during takeoff and landing? Why?

12. Describe the technique for power-off sailing:

13. Describe the technique for docking the floatplane:

14. Describe the technique for beaching the floatplane:

15. List three reasons why a floatplane porpoises:

Match the following:

16. Separates float compartments	A. Keel
17. Walking area on top of float	B. skeg
18. Reinforcement strip that connects side and bottom of float	C. bulkhead D. spray rail

19. Reinforcement strip on float bottom — E. step
20. Deflects water away from prop — F. chine
21. Least drag, best acceleration point — G. deck
22. When taxiing on water, what is the best way to determine the wind direction?
    a) narrow band of slick water next to the shore line.
    b) wind streaks.
    c) birds pointing into the wind
    d) letting the floatplane weathervane into the wind
23. When flying, what is the best indication of wind direction?
    a) narrow band of slick water next to the shore line.
    b) wind streaks.
    c) wave movements.
    d) shore line reference, such as smoke, etc.
24. Why does the floatplane turn downwind in the plow position?
    a) using the air and water rudders turns the floatplane.
    b) centrifugal force.
    c) center of buoyancy shifts forward.
    d) center of buoyancy shifts aft.
25. What method is used to stop severe porpoising?
    a) control pressure slightly back from neutral.
    b) control pressure slightly forward.
    c) power to idle, control pressure full aft.
    d) try to catch the porpoise by adjusting pitch and power.
26. The method for glassy water landings:
    a) pitch up at or before the LVR, then set power to glassy water setting.
    b) set power to glassy water setting, then pitch up over the LVR.
    c) land parallel to the shore line, using shore line as the LVR.

d) land the floatplane the same as soft field technique for land planes using the the surface of the water as LVR.

27. The gross weight of the PA-18 Super Cub 150 amphib? Land? Water?

28. Useful load is?

29. Fuel capacity is?

33. Best rate of climb airspeed/flap configuration is?

34. Best angle of climb airspeed/flap configuration?

35. Best glide airspeed/flap configuration?

36. What certificates and documents have to be on board the floatplane?

37. What documents do you need to act as pilot-in-command?

38. How long is a second class medical valid?

39. List five ways to determine wind direction:

40. Who has the right-of-way, boats or floatplanes? Why?

41. White caps start to form on the top of waves at approximately?

42. Wind streaks start to form on the water surface at?

43. Who has the right-of-way, the floatplane taking off or the floatplane landing?

44. What is the color of the rotating beacon at a seaplane base, and what symbol is used for a seaplane base on a sectional chart?

45. As far as design, what is the most important area of the float? Why?

46. On floatplanes, what is the most important part of the preflight? Why?

47. What does the model number "2100" represent on a float?

48. How much of the floatplane's gross weight must each float support?

49. What is the purpose of the skeg?

50. If a 90° x-wind is encountered on takeoff, which is preferred, left or right x-wind? Why?

51. Far 91.115 states, in part that "aircraft on the water"?

52. How can a floatplane pilot determine which bodies of water can be landed upon?

53. List 5 items that a good floatplane pilot looks for when flying over a potential landing site?

54. Describe the technique for the plow turn and what force makes the floatplane turn downwind from the plow position? Why?

55. Should you turn into the wind in the plow position? Why?

56. Describe a maximum performance takeoff?

57. How much do the floats weigh?

58. Location of the battery?

59. Electrical system volts? Amps?

60. How much anchor rope is necessary to anchor in 10 feet of water?

61. What is the maximum flap setting for this floatplane?

62. Explain spin recognition and recovery techniques.

Study Quiz Answers

1. Idle - (except in high winds where you might bury a float in a turn)

2. Plow - Overheating, prop-spray, poor visibility

3. Plow Taxi Turn - Center of buoyancy moves aft reversing the weather-cocking

4. Upwind - Centrifugal force and the wind direction work together causing a capsizing effect. (You're leaning to the outside of the turn)

5. F.A.R.T.S.

6. Glassy Water - loss of depth perception. (that can't be learned) The calmness tends to make the pilot relaxed and complacent which makes the situation more dangerous.

7. Glassy Water Take Off
   Taxi in a circle to create wake which will expand across the surface
   Lift right float at ~45 MPH (but don't pull back yet)
   Rotate normally 50 MPH
   Level wings when both floats are out of the water
   Pay attention. Don't fly back into the water

8. Weathervane/Weathercock

9. Stick Back

10. Step Taxi

11. Up - The air rudder provides adequate directional control. (you would just bang them around)

12. Water Rudders Up (they would steer you the wrong direction) Stick in the direction you want to turn (follow your thumbs) Opposite Rudder

13. Plan, Evaluate, Slow, Slow by Flaps, into the Wind, Doors Open, Carb Heat, 1 Mag, Mags Off, Coast In, Air Horn, Fend Off with Oar (call the insurance co.!)

14. Inspect - Obstacles and Mud
   Sail In, if practical
   Taxi at 45° Angle (so you can change your mind)
   Cut Power - glide In
   Tides? - pull tail in on the beach
   Don't Leave Unattended
   Anchor

15. The stick is too far back or forward (digging in or dragging the tail of float) Pilot Induced Oscillations, Boat Wake, Aft C.G., Too low power setting on step taxi turn

16. C

17. G

18. F

19. A

20. D

21. E

22. D

23. A

24. D

25. C

26. A

27. 2000 lbs max gross weight water, 2000 max take off weight land, 2000 max landing weight land

28. 524 water, 524 land takeoff, 524 land landing

29. 36 gallons max, 18 gallons inboard in each wing

33. Best Rate 73 MPH - Flaps, First Notch 0°

34. Best Angle 70 MPH - Flaps, Second Notch 25°

35. Best Glide 73 MPH - Flaps, First Notch 0°

36. A.R.R.O.W. (Airworthiness Certificate, Registration, Radio Station License(outside US), Operating Manual, Weight and Balance

37. Pilot Certificate, Medical, Photo ID

38. One year as 2nd class

39. Idle with water rudders up, Glassy Area, Wind Streaks, Wind Sock - Flags, Smoke, Local ATIS

40. Boats have right-of-way (they typically do not know the right of way rules)

41. White Caps - 12 KTS

42. Wind Streaks 8-12 KTS

43. Seaplane taking off has Right-of-way

44. Yellow/White, Anchor

45. Step, Less Drag Area

46. Inspect Floats, You Sink!

47. The float displaces 2185 lbs of fresh water

48. Each float - 90% of Gross Weight

49. Skeg protects the rear of the step

50. Right x-wind, because with a left x-wind, you may run out of right rudder authority.

51. "will avoid impeding the navigation of any other vessel."

52. Overfly area for 20 sec at cruise power - Land/T.O.

53. Obstructions, Wind, Water Depth, Water Condition, Traffic - Boats/Planes, Currents

54. Plow Turn
    Stick back
    Start into wind with water rudders down
    At idle power, swing nose right(20°) then full left rudder
    As nose swings to left of wind, Add enough power to plow, nose high - tail low
    Continue Left rudder to turn - ailerons toward the wind
    When downwind, power off, ailerons neutral

55. No, Capsize

56. Max Performance Take Off
    - Place on the step
    - 25° Flaps
    - Lift Right float out of the water at ~45 MPH
    - Rotate to best angle(Vx) 73 MPH
    - At 100-200 ft, flaps to zero, decelerate to (Vy) 70 MPH

57. Floats Weigh ~407 lbs Total

58. Battery is located under rear seat

59. Electric system 14 Volts 50 Amps

60. 50-70 Feet depending on type of anchor

61. Max Flap 50°
    0° 1st notch (climb, slow cruise)
    25° 2nd notch (Takeoff & Glassy Water Ldgs)
    50° 3rd notch (Normal & Rough Water Ldgs

62. Rudder opposite, power to idle, aileron neutral, stick forward, neutralize rudder when spin stops, then recover wings level, power as necessary.

SEAPLANE PASSENGER BRIEFING—NOTES FOR THE PILOT

(A *Sample Seaplane Pilots' Passenger Briefing Checklist* follows the *Discussion*)

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Preface: This document may well provide the most comprehensive inventory of passenger briefing issues you have yet encountered. ***However it is not itself a passenger briefing. Rather, it is a tool for developing your own passenger briefings.*** You may also consider it an aid to help to develop an unofficial supplement to your Pilots Operating Handbook (POH).

There are many important reasons why seaplane pilots should provide passenger briefings:

- To fulfill their responsibilities as pilot in command for the safe operation of their aircraft,
- To improve passenger safety,
- To satisfy FAA regulations (such as 14 C.F.R. 91.107) that require passenger briefings,
- Commercial operators have even more stringent briefing requirements, and
- To help passengers understand that their survival during an accident is highly dependent on their knowledge and use of safety information.

Because of the unique risks of seaplane flying and the non-intuitive nature of accident and passenger survival procedures, this document is designed as a flexible, robust tool to help craft effective passenger briefings. Effective passenger briefings help prevent accidents and encourage appropriate passenger response in the event of an accident.

Despite the importance of passenger briefings, pilots enjoy great discretion in how to fashion them. Some pilots think that "telling the passenger too much" or describing emergency procedures in detail is counterproductive and may frighten passengers or even convince them not to fly. Others find that passengers both appreciate and benefit from comprehensive preflight briefings and will fly with greater confidence when they know what to expect and believe that the pilot cares about their welfare. ***Achieving the right balance is up to you. How thoroughly to brief your passengers is one of the many choices you make as a responsible pilot.***

**

I. DISCUSSION (FOR PILOTS)

a. Background.

An upset (capsizing) is a life-threatening event for seaplane passengers. The very limited time in which to escape the cabin when it fills with water and the likelihood of major structural damage from water impact (possibly causing doors or windows to jam) contribute to the danger. During such a crisis you may be preoccupied with managing the plane and be unable to give instructions or otherwise attend to passengers beyond ordering them to evacuate.

Furthermore, if you become incapacitated in a water impact emergency, your passengers need to know what to do and how to do it without your assistance. Since seaplanes involved in an accident tend to come to rest inverted in water and can remain afloat for long periods if the floats are not breached, the FAA emphatically stresses the importance of a thorough preflight passenger briefing on proper egress procedures.

Evacuation of a seaplane entails problems not associated with evacuation of a landplane. Therefore, passengers need seaplane-specific briefings, which include information about the location and operation of normal and emergency exits, flotation gear, seatbelts, shoulder harnesses, etc.

A 15-year study of seaplane accidents in North America, covering 103 accidents on water, revealed that 61% of the pilots died. Of those, 78% died inside the aircraft cabin. Of those, 81% drowned. Of those who drowned, 14% were incapacitated from non-fatal impact forces and subsequently drowned, and 67% died from drowning alone with no other injuries sustained. Statistics for the passengers were similarly tragic. Many were found still in their seatbelts and unharmed except for drowning (see *A Safety Study of Survivability in Seaplane Accidents,* in Additional Resources, below). These sobering statistics highlight the compelling need for thoughtful and well-executed passenger briefings. In addition, pilots—and passengers who fly over water often—should complete underwater egress training (*see* Section c(10)(b), below).

Pilots should consult the POH or AFM for any special evacuation procedures specific to the aircraft.

b. Presentation.

Deliver your pre-takeoff oral briefing before starting the engine(s), beginning outside the cabin so passengers can easily hear and see demonstrations of proper emergency procedures. Speak clearly and distinctly, physically point out the plane's regular and emergency exits and all safety equipment on board, and explain how the exits and safety equipment are operated. Tell and show passengers the names of the parts of the aircraft covered in the briefing, such as *chine*, *float deck*, *lift strut*, etc. Whenever practicable, physically demonstrate how to operate the exits and use the safety equipment. When an actual demonstration is not practicable (such as for the inflation of flotation gear), simulate the actions involved as closely as possible.

c. Pre-takeoff Briefing.

Before each flight, brief passengers on each of the following:

(1) How to enter and exit the cabin. Before passengers board the aircraft is a good time to point out the dangers posed by the propellers and horizontal stabilizer and to identify parts of the aircraft you will reference during briefings. Urge passengers to exercise extreme caution near any propeller. Serious injuries, amputations, and death have resulted from propeller strikes and, for persons on the dock, from contact with the horizontal stabilizer. Instruct

passengers not to assist with docking or other pre- or post-flight operations unless their help is specifically requested. If you require such assistance, brief specific instructions, including the dangers and avoidance of spinning propellers and the proper handling of the horizontal stabilizer and lines. Demonstrate boarding or departing the amphibian if the flight begins or ends on land.

(2) How to fasten, tighten, and unfasten the safety belt and shoulder harness by feel, and how to stow the loose end of the seatbelt so it does not hinder seatbelt release in the event of an emergency.

(3) How to recognize (by feel) seatbelt rollover. Seatbelt buckles will occasionally roll over due to deceleration forces, making it impossible to activate the release lever. This condition must be identified and the buckle rolled upright before it can be released.

(4) How to move seats forward and backward to enhance egress and how to ensure the seats are locked in place before takeoff and landing.

(5) That all adjustable seat backs should be upright for takeoff and landing.

(6) The location of each normal and emergency exit and its operation (by a demonstration, if practical).

(7) The need to leave carry-on items behind in the event of an upset and evacuation.

(8) The need to establish situational awareness to aid passenger egress in the unlikely event of an upset. In other words, help passengers establish a frame of reference to keep them oriented in the event of an accident, such as *left hand on the left knee* or *left armrest or right hand toward the direction of the exit.*

(9) How to clear an egress pathway, remove headphones and clear the cord, establish a reference handhold, then release seatbelts/harnesses and clear them out of the way. Once situational awareness is established, an exit path chosen and cleared, a handhold established, and seat belts are released and cleared, passengers can use a hand-over-hand technique to make their way to and out of an exit (after the aircraft stops moving and the cabin has filled with enough water to equalize pressures so the door or window may be opened).

Using positional and situational awareness and the hand-over-hand technique decreases the possibility of passenger disorientation. Stress that left and right are the same whether a passenger is upright or inverted. That is, if an exit is on a passenger's right while the plane is upright, it will still be on the passenger's right if the plane is inverted.

Make all directional references in relation to the passengers' right or left, not yours. Advise passengers whether the door handle on the inside of the airplane will work in reverse (in case the plane is upside down), and that when the door is closed and locked (as in flight), it may be impossible to open from the outside.

Once passengers have evacuated the seaplane, they may inflate their Personal Flotation Devices (PFDs) if needed. To avoid hypothermia, passengers should get out of the water as soon as possible. They can move hand-over-hand along the float to the bow or stern then to the area between the floats in order to use the spreader bar as an aid in getting onto a float. If there is oil or fuel contamination in the water, passengers should move away from it, upwind or upstream as needed, along the float and then get up onto the float to avoid the contamination.

(10) Unless the seaplane is used for hire, sightseeing or flight instruction, PFDs are not required by U.S. law. Nonetheless, it is prudent to have them on board and it is *most* prudent to have them worn. PFDs are required for all seaplanes in Canada. The U.S. Coast Guard, as

well as some state and local authorities, may require PFDs during water operations. The FAA recommends the use of FAA- or USCG-approved, *inflatable* PFDs in not-for-hire operations. Inflatable PFDs are activated/inflated either *manually* or *automatically*. The automatic-activation PFDs utilize a water-soluble switch that typically activates in five seconds when immersed in water (and sometimes activate from moisture in the air). Clearly this type of PFD should not be used for seaplane operations. The manual-activation PFDs are classified as either Type III or Type V, based on their minimum buoyancy of 22.5 or 34 lbs. Non-inflatable, wearable floatation devices are *not* recommended for small aircraft.

(a) Brief passengers on the type, location, and use of PFDs, including a demonstration of how to put them on and how to inflate them *after* exiting the cabin (such as by carbon dioxide (CO_2), orally, or by other manual methods).

Emphasize to passengers that an inflatable PFD must NOT be inflated until they are clear of wreckage after exiting the seaplane, since PFDs can easily get hung up or punctured on wreckage, block an exit, or prevent a passenger from exiting an inverted seaplane.

(b) Underwater egress training is strongly recommended for seaplane pilots and suggested for passengers who often fly over water beyond gliding distance to shore. *See* Additional Resources, below.

(c) If flotation cushions are aboard, brief passengers on their location and use, including a physical demonstration, if practicable, of how to insert arms through the straps and rest the torso on the cushion once in the water. Caution passengers not to wear the cushion on their backs. Note: flotation cushions are sometimes used aboard seaplanes as seat cushions and, as a practical matter, can be utilized as throwable life-saving devices and fenders. Although they are not recommended for use as PFDs in seaplanes, this use should be included in passenger briefings if such flotation cushions are aboard. (*See* AC 91-69A, *Seaplane Safety for FAR Part 91 Operators*, p. 12 for applicable requirements).

(11) Brief passengers on the location and operation of any fire extinguishers; first aid kits, and survival gear including all Emergency Locator Transmitters (ELTs), Personal Locator Beacons, and pyrotechnic signaling devices (flares).

(12) Appropriate brace positions and the proper location for carry-on items.

(13) Proper stowage of lines, anchors, paddles, cargo and baggage, both to avoid having loose items hinder underwater egress from the cabin and to avoid having loose items wreak havoc in case of a rapid deceleration. Consider that in a nine-g deceleration, an object the size of a typical (2 AA cell) flashlight placed on the hat rack behind the seats could hit your head with more energy than a 9 mm bullet! Just think what the anchor or a piece of luggage would do.

d. Passengers Needing Special Assistance.

Individually brief passengers who may require special assistance. In addition to the above information, these briefings should also designate who will assist the passenger in an emergency. If the passenger is accompanied by an attendant, brief both the passenger and the attendant to accommodate their special needs. Determine if any passengers are weak- or non-swimmers, and strongly encourage such passengers to wear PFDs during all operations.

e. Pre-landing Briefing.

Before each landing, at a minimum, brief passengers to fasten seatbelts and shoulder harnesses (if installed), to place adjustable seat backs in the upright position, and to stow all carry-on items.

f. Pre-docking Briefing.

Brief passengers to remain seated until the door is opened and you signal that it is safe to exit. If passenger assistance will be needed to accomplish docking or beaching, brief that passenger completely on how to perform the necessary maneuvers safely. For example, caution the passenger never to move forward of the lift strut. Some pilots prefer to give a pre-docking briefing or refresher immediately prior to docking to prevent confusion. Generally, unless the passenger is an experienced seaplane pilot, it is best not to expect the passenger's aid during departure or arrival.

g. Additional Considerations.

When developing your own passenger briefing checklist, you may wish to consider adding additional issues appropriate to your own craft, and flying preferences, such as:

Headsets and Intercom: "You will be given a headset upon boarding to protect your hearing from engine noise and to provide an intercom between the plane's occupants. The knobs on your headset control the volume. Keep the microphone very close to your mouth when speaking (otherwise it won't work). If you are occupying the co-pilot's seat, you may adjust a co-pilot/passenger volume/squelch control. If you like, I can isolate passengers from aviation communications to permit you to talk privately, but then you will not be able to talk to me."

Physiological Effects of Flying: "You may experience many physiological effects of flight including disorientation (when banking or due to g forces), illusions (particularly when in the clouds), "red out" when looking through the propeller into the sun; about one out of seven passengers may experience it – manifestations range from seeing everything in the color red, to, in extreme cases, seizures."

Co-pilot's Controls: "If you sit in the co-pilot's seat, please do not touch or obstruct extension of the control wheel [stick] or other controls. I will demonstrate the full-extension of the controls so that you can become comfortable with the needed clearances."

Talking: "Please limit conversation during taxiing, take-off, and landing. It is good practice for pilots to enforce a "sterile cockpit" – silence among crew and passengers except for needed operational communication – during these critical flight operations. I need to listen for instructions from airport control towers and control facilities and must remain particularly alert. One exception: because passengers are an important safety resource, please identify – physically, by pointing – any nearby airborne aircraft that you see."

Lights and Noises: "Many flashing lights, aural alarms, and the like are part of normal flight operation, particularly during departure and arrival. Please do not be startled by them. If they worry you, ask me about them when it appears I am not busy."

Environmental: "The plane is heated. If you are cold, ask me to increase the heat. If you desire cool air, I will show you the location and operation of the air vents."

Hazardous Materials: "Do not board flammable substances or aerosols, such as lighters, lighter fluid, propane, gasoline or flammable gases, strike-anywhere matches, mace, tear gas, hair spray, or dry ice, without first obtaining my permission."

Medications, Drugs and Medical Condition: "If you are taking medications that may impair your judgment or affect normal health, if you have any medical or related conditions/predispositions including, for example, anemia, acrophobia, claustrophobia, epilepsy or nervous disorders, if you wear a hearing aid, or if you have been scuba diving in the past 48 hours, please notify me before the flight."

Illicit Substances: "The use or transportation of illicit substances is strictly prohibited."

Health: "If you become ill or feel any discomfort for any reason, please inform me immediately. Subject to safety requirements and the instructions given me by air traffic controllers, I will terminate the flight upon your request."

Air Sickness & Ear Comfort: "Airsickness bags are located in your seat pocket. Locate them when you board, and please have one ready! Separately, for your comfort, clear your ears when descending, by swallowing or chewing, as the airplane is not pressurized. If you cannot clear an ear, notify me immediately."

Clothing: "Bring clothing appropriate for the route. Also, the weather may vary considerably following departure. Wear light shoes or sneakers but pack hiking boots and weather gear if a mountain flight. Sunglasses and hat/visor are advisable. Avoid polyester clothing for fire safety."

Liquids: "Restrict consumption of liquids prior to and during the flight, especially diuretics such as coffee, tea, and alcohol. There is no toilet on the plane!"

Medications: "Bring essential personal medications and essential toiletries in the event that we must unexpectedly remain overnight at an unplanned destination."

Weight and Balance: "Please be prepared to provide me your fully clothed weight and the packed weight of each piece of luggage you desire to bring. Keep luggage weight and size to a minimum. Soft bags such as duffel bags are preferred for flexible loading."

**

II. SAMPLE SEAPLANE PILOTS' PASSENGER BRIEFING CHECKLIST

Before entering the cabin:

(1) How to enter and exit the cabin. Avoidance of propellers and stabilizer.

(2) Smoking or other restrictions.

(3) Egress following upset:

a. leave carry-on items behind,

b. establish situational awareness,

c. clear a pathway out,

d. establish a reference handhold, then release seatbelt,

e. exit using hand-over-hand technique,

f. how to wear and when to inflate flotation gear, and

g. what to do once outside the seaplane.

(4) Fire extinguishers, first aid kits, survival gear, ELT, stowage of carry-on items, loose items, and aircraft equipment.

(5) Passengers needing special assistance, including passengers who are weak or non-swimmers.

(6) Additional considerations that are best discussed before entering cabin (*from above list or your materials*).

After entering the cabin:

(7) Safety belt and shoulder harness operation, and stowage of loose end of the seatbelt.

(8) Release of seatbelt, including when buckle is inverted.

(9) Seat operation to enhance egress.

(10) Adjustable seat back upright and latched for takeoff and landing.

(11) An appropriate brace position.

(12) Location and operation of each normal and emergency exit, including unlatching doors, if appropriate.

(13) Pre-landing briefing.

(14) Pre-docking briefing.

(15) Additional in-cabin considerations (*from above list or your materials*).

**

III. ADDITIONAL RESOURCES

a. General.

A listing of government publications on seaplane operations:
< http://www.seaplanes.org/library/govtpubs.htm >

A Safety Study of Survivability in Seaplane Accidents, Transport. Safety Bd. of Canada (1994) < http://www.tsb.gc.ca/en/reports/air/studies/sa9401/sa9401.asp >

Flying with Floats (TP 5584e), Transport Canada
< http://www.seaplanes.org/library/govtpubs/tp5584e.htm >

Seaplane Pilot, Dale DeRemer (ASA 2003)
< http://www.asa2fly.com >

Seaplane Pilots' Model Code of Conduct
< http://www.secureav.com/SeaplanePMCC-v1.1.pdf >

Seaplane Safety for 14 CFR Part 91 Operators (AC 91-69A)
< http://www.seaplanes.org/library/govtpubs/AC91-69A.pdf >

Seaplane, Skiplane, and Float/Ski Equipped Helicopter Operations Handbook (FAA-H-8083-23) < http://www.faa.gov/library/manuals/aircraft/seaplane_handbook/ >

The Flight Training Handbook, Ch. 15 - Seaplane Operations (AC 61-21A)
< http://www.seaplanes.org/library/govtpubs/AC61-21A.pdf >

Seaplane underwater egress training is strongly recommended, such as with:
< http://www.dunk-you.com >

The FAA Aviation Safety Program has produced an excellent series of videos, including one that addresses passenger briefings for seaplane operators, entitled *Seaplane Safety: What Every Passenger Needs to Know*, available from the FAAST Team Manager at your local Flight Standards District Office (FSDO).

b. Sample Passenger Briefings.

The following third-party passenger briefings are provided for the limited purpose of helping pilots explore the scope and diversity of some actual passenger briefings. These briefings are not necessarily appropriate for a particular implementation.

Survival Checklist, CheckMate
< http://www.CheckMateAviation.com >, Tel. 800-359-3741

Passenger Briefing Checklist, Dale DeRemer, *Seaplane Pilot*, p. 39 (ASA 2003)
< http:www.asa2fly.com >

Passenger Preflight Briefing Cards, Columbia Seaplane Pilots
< wileyseaplanes@comcast.net >

A Sample Passenger Briefing Package
< http://www.secureav.com/briefing.doc >

**

NOTICE

Seaplane pilots and the aviation community may use this document as a resource for passenger briefing development, although it is recommended that this be supported by independent research on the suitability of its content for specific or local applications and situations. It is not intended to provide legal advice and must not be relied upon as such. It is neither a "standard" nor intended to be implemented as such.

EDITS, ERRATA, COMMENTS

This is a living document, intended to be updated periodically to reflect changes in seaplane practices and the aviation environment. Please send your suggestions, edits, errata, questions and comments to: < PEB@secureav.com >.

ACKNOWLEDGMENTS

The *Seaplane Passenger Briefing—Notes for the Pilot* has had the benefit of extensive editorial comment and suggestions by a diverse body of the seaplane community, and beyond. *See* "Acknowledgments" at < http://www.secureav.com >. The Seaplane Passenger Briefing Drafting Group included: Michael S. Baum, Robert B. Curtis, Prof. Dale DeRemer, Ray Hawco, David Wiley, and Walter B. Windus. The Permanent Editorial Board of the *Aviators' Model Code of Conduct* is presented at < http://www.secureav.com/PEB.pdf >.

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FAA APPROVED

AIRPLANE FLIGHT MANUAL SUPPLEMENT

FOR

AMPHIBIAN OPERATION

IN THE

SUPER CUB MODEL PA-18-150, PA-18A-150

WITH STC SA682AL (160 BHP)

WIPLINE MODEL 2100 AMPHIBIOUS FLOATS
(At a gross weight of 2000 pounds)

REG. NO. N8177D

SER. NO. 18-6105

This Supplement must be attached to the FAA Approved Airplane Flight Manual when the airplane is modified by the installation of Wipline Model 2100 floats in accordance with STC SA00713CH . The information contained herein supplements or supersedes the basic FAA Approved Airplane Flight Manual only in those areas listed. For limitations, procedures, and performance information not contained in this Supplement, consult the basic airplane placards, markings, and the AFM as applicable.

FAA APPROVED: Joseph C Mucas
for Royce Prather, Manager
Chicago Aircraft Certification Office
FAA Central Region

Date: OCT 22 1998

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OCT 2 2 1998

LOG OF REVISIONS

REV. NO.	PAGES	DESCRIPTION	DATE	FAA APPROVED*

* Approved by Manager, Chicago Aircraft Certification Office.

NOTE: Revised text is indicated by a vertical black line along right margin.

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OPERATING LIMITATIONS

1. Airspeed Limitations (CAS)

SPEED	MPH	KNOTS
Never Exceed Speed (V_{NE})	129	112
Maximum Structural Cruising Speed (V_{NO})	102	89
Maneuvering Speed (V_A)	97	84
Flaps Extended Speed Limit (V_{FE})	80	70
Landing Gear Extended/Operating Speed Limit (V_{LO})	129	112

Airspeed Indicator Markings*

A tape or decal red radial line must be affixed to the glass face of the airspeed indicator at 129 mph.

* See required placards list later in this section for list of airspeed limits applicable to amphibian.

In lieu of the above:

Redline - Never Exceed Speed ..... 129 mph
Yellow Arc - Smooth Air Cautionary Range ..... 102 to 129 mph
Green Arc - Normal Operating Range From Flaps Up Stall Speed to V_{NO} ..... 56 to 102 mph
White Arc - Flap operating Range From Flaps Down Stall Speed to V_{FE} ..... 53 to 80 mph

2. Powerplant

Engine .....Lycoming O-320-B2B or O-320-A2B as modified by STC SE2315NM
Power.....160 BHP rated
Maximum Oil Temperature..... 245°F
Oil Pressure - Minimum ..... 25 psi
Maximum..... 100 psi
Fuel Grade - Minimum.....100LL
Propeller ..... McCauley 1A175/GM8244
Diameter - Maximum..... 82 inches
Minimum ..... 80.5 inches
Static RPM at Full Throttle ..... 2375 to 2475 RPM

Powerplant Instrument Markings

Tachometer
Redline - Maximum Engine Speed..... 2700 RPM
Green arc - Normal Operating Range ..... 500 to 2700 RPM
Oil Temperature Gage
Redline - Maximum Safe Temperature..... 245°F
Green Arc - Normal Operating Range .....100 to 245°F
Oil Pressure Gage
Redline - Maximum Pressure ..... 100 psi
Yellow Arc - Cautionary Range..... 85 to 100 psi
Green Arc - Normal Operating Range..... 60 to 85 psi
Yellow Arc - Cautionary Range..... 25 to 60 psi
Redline - Minimum Pressure..... 25 psi

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3. Weight Limitations

Maximum Weight..... 2000 pounds
Empty Weight and Center of Gravity ..... See Aircraft Weight and Balance Papers
Useful Load ..... See Aircraft Weight and Balance Papers
Composition of Useful Load ..... See Aircraft Weight and Balance Papers

4. Load Distribution Limitations

Center of Gravity Limits (inches aft of wing leading edge)
14.0 to 18.0 inches at 2000 pounds,
10.5 to 18.0 inches at 1300 pounds or less,
Straight line variation between points given above.

5. Maneuvers

This airplane is certificated in the Normal Category. The Normal Category is applicable to aircraft intended for non-aerobatic operations. These include any maneuvers incidental to normal flying, stalls, lazy eights, chandelles, and turns in which the angle of bank is not more than 60°.

Aerobatic maneuvers, including spins, are prohibited.

6. Flight Load Factor

Maximum Positive Load Factor..... 3.8 g
Maximum Negative Load Factor .....No inverted maneuvers are permitted

7. Other Limitations

Water rudders must be retracted for all flight operations.
Landing on water is **PROHIBITED** unless all four landing gear are fully retracted.

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8. Placards

The following placards which supplement or replace landplane placards must be displayed in the amphibian:

Floatplane Operations Limitations

The markings and placards installed in this airplane contain operating limitations which must be complied with when operating this airplane in the Normal Category: Other operating limitations which must be complied with when operating this airplane in this category are contained in the Pilot's Operating Handbook and FAA Approved Airplane Flight Manual Supplement

No acrobatic maneuvers, including spins, are approved.

Flight into known icing conditions is prohibited.

This airplane is certified for the following flight operations as of date of original airworthiness certificate.

DAY --- NIGHT --- VFR --- IFR

DO NOT LAND ON WATER UNLESS GEAR IS FULLY RETRACTED

EMERGENCY HANDPUMP

PULL GEAR MOTOR CIRCUIT BREAKER
SELECT DESIRED GEAR POSITION
PUMP GEAR TO DESIRED POSITION

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At the upper blue landing gear lights -	**NOSE**
At the lower blue landing gear lights -	**MAIN**
At the red landing gear light -	**PUMP**
At the upper green landing gear lights -	**NOSE**
At the lower green landing gear lights -	**MAIN**
At the landing gear actuation switch -	**UP** **WATER** **DOWN** **LAND**

REFER TO WIPLINE AFM SUPPLEMENT FOR OPERATION WITH WIPLINE FLOATS INSTALLED

AMPHIBIAN/FLOATPLANE AIRSPEED LIMITATIONS

Flap Extended Speed Range	Stall	53 mph CAS
	To V_{FE}	80 mph CAS
Normal Operating Speed Range	Stall	56 mph CAS
	To V_{NO}	102 mph CAS
Cautionary Speed Range	V_{NO}	102 mph CAS
	To V_{NE}	129 mph CAS
Never Exceed Speed	V_{NE}	129 mph CAS
Maneuvering Speed	V_A	97 mph CAS

WATER RUDDER UP FOR ALL FLIGHT OPERATIONS

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OPERATING PROCEDURES

WARNING

There is no substitute for proper and complete preflight planning habits and their continual review in minimizing emergencies. Be thoroughly knowledgeable of hazards and conditions which represent potential dangers, and be aware of the capabilities and limitations of the airplane.

All operating procedures for this airplane are generally conventional.

However, do not land on water unless landing gear are fully retracted.

If landing gear will not extend in the normal fashion, extend (or retract) them in accordance with the placard in the airplane:

Pull Gear Motor Circuit Breaker
Select Desired Gear Position With Manual Valve
Pump Gear To Desired Position

Takeoffs from larger bodies of water should always be made into the wind. The chop/waves generated in winds of 10 knots and more may inhibit engine operation due to spray and may prevent the airplane from attaining the step under these conditions in crosswinds.

NOTE

When floats are installed, it is possible to exceed the maximum takeoff weight with all seats occupied and minimum fuel.

WARNING!!

It is the responsibility of the pilot to ensure that the amphibian is loaded properly. Operation outside of prescribed weight and balance limitations could result in an accident and serious or fatal injury.

FLOAT BAGGAGE COMPARTMENTS

Baggage may be carried in the float baggage compartments in accordance with the following limitations:

COMPARTMENT	MAX WT	ARM	MOM
LEFT	50 Lbs.	55	2750
RIGHT	50 Lbs.	55	2750

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PERFORMANCE INFORMATION

INTRODUCTION

This section provides the performance information on the PA-18 amphibian required under CAR 3. All airspeeds are presented in terms of calibrated airspeed (CAS). The pilot must use available material for his particular airplane to determine the corresponding indicated airspeed. Under the original certification of the PA-18 at speeds between 1.3 times the stall speed with flaps up and V_{NO} and at 1.3 times the stall speed with flaps down the indicated airspeed was within ± 5 mph of the calibrated airspeed.

STALLING SPEEDS

Conditions:
Power Off
2000 Pounds

MOST FORWARD CENTER OF GRAVITY

WEIGHT LBS	FLAP POSITION	ANGLE OF BANK			
		0°	30°	45°	60°
		MCAS	MCAS	MCAS	MCAS
2000	0°	56	60	66	79
	25°	54	58	64	77
	50°	53	57	63	75

MOST REARWARD CENTER OF GRAVITY

WEIGHT LBS	FLAP POSITION	ANGLE OF BANK			
		0°	30°	45°	60°
		MCAS	MCAS	MCAS	MCAS
2000	0°	54	58	65	77
	25°	53	57	63	75
	50°	52	56	62	74

TAKEOFF DISTANCE OVER 50 FOOT OBSTACLE
MAXIMUM WEIGHT 2000 LBS

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TAKEOFF DISTANCE OVER 50 FOOT OBSTACLE
MAXIMUM WEIGHT 2000 LBS

WATER TAKEOFF

CONDITIONS:
Flaps 25°
Full Throttle, Mixture Rich (Below 3000') or Best Power (Above 3000')
Rippled Water
No Wind
Obstacle Clearance Speed Is 70 MCAS

Notes:
1. Shaded area of chart denotes possible frozen water. Distances are provided to allow interpolation.
2. Mixture may be leaned above 3000 feet for increased power.
3. Water distance is estimated to be **approximately** 60% of total distance to obstacle height.
4. Distances in excess of 3000 feet are approximate and should be used with caution.

PRESSURE ALTITUDE ft	STD. TEMP. °F	STD. TEMP. - 60°F DISTANCE TO CLEAR 50' OBSTACLE ft	STD. TEMP. - 40°F DISTANCE TO CLEAR 50' OBSTACLE ft	STD. TEMP. - 20°F DISTANCE TO CLEAR 50' OBSTACLE ft	STD. TEMP. DISTANCE TO CLEAR 50' OBSTACLE ft	STD. TEMP. + 20°F DISTANCE TO CLEAR 50' OBSTACLE ft	STD. TEMP. + 40°F DISTANCE TO CLEAR 50' OBSTACLE ft
SL	59	1593	1709	1830	1956	2087	2223
2000	52	1903	2053	2211	2377	2551	2734
4000	45	2322	2524	2739	2967	3209	3468
6000	38	2916	3202	3512	3847	4210	4604
8000	31	3817	4257	4745	5289	5897	6581

GROUND TAKEOFF - SHORT FIELD

CONDITIONS:
Flaps 25°
Full Throttle, Mixture Rich (Below 3000') or Best Power (Above 3000')
Paved, Level, Dry Runway
No Wind
Obstacle Clearance Speed Is 70 MCAS

Notes:
1. Mixture may be leaned above 3000 feet for increased power.
2. Ground distance is estimated to be **approximately** 50% of total distance to obstacle height
3. Landing gear down till obstacle cleared..
4. Distances in excess of 3000 feet are approximate and should be used with caution.

PRESSURE ALTITUDE ft	STD. TEMP. °F	STD. TEMP. - 60°F DISTANCE TO CLEAR 50' OBSTACLE ft	STD. TEMP. - 40°F DISTANCE TO CLEAR 50' OBSTACLE ft	STD. TEMP. - 20°F DISTANCE TO CLEAR 50' OBSTACLE ft	STD. TEMP. DISTANCE TO CLEAR 50' OBSTACLE ft	STD. TEMP. + 20°F DISTANCE TO CLEAR 50' OBSTACLE ft	STD. TEMP. + 40°F DISTANCE TO CLEAR 50' OBSTACLE ft
SL	59	1202	1293	1388	1488	1592	1702
2000	52	1460	1582	1711	1847	1992	2146
4000	45	1824	1996	2181	2381	2597	2831
6000	38	2373	2636	2926	3249	3609	4012
8000	31	3291	3747	4275	4895	5629	6512

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LANDING DISTANCE OVER 50 FOOT OBSTACLE
MAXIMUM WEIGHT 2000 LBS

WATER LANDING

CONDITIONS:
Flaps 50°
Throttle Idle
Obstacle Clearance Speed Is 69 MCAS
No Wind
Rippled Water

Notes: 1. Shaded area of chart denotes possible frozen water. Distances are provided to allow interpolation.
2. Water distances are estimated to be **approximately** 50% of total landing distance from 50 foot obstacle height.

PRESSURE ALTITUDE ft	STD. TEMP. °F	STD. TEMP. - 60°F DISTANCE TO CLEAR 50' OBSTACLE ft	STD. TEMP. - 40°F DISTANCE TO CLEAR 50' OBSTACLE ft	STD. TEMP. - 20°F DISTANCE TO CLEAR 50' OBSTACLE ft	STD. TEMP. DISTANCE TO CLEAR 50' OBSTACLE ft	STD. TEMP. + 20°F DISTANCE TO CLEAR 50' OBSTACLE ft	STD. TEMP. + 40°F DISTANCE TO CLEAR 50' OBSTACLE ft
SL	59	1259	1304	1349	1393	1438	1483
2000	52	1312	1361	1409	1457	1505	1553
4000	45	1371	1423	1474	1526	1578	1629
6000	38	1434	1490	1545	1601	1656	1711
8000	31	1502	1562	1622	1682	1741	1801

GROUND LANDING - SHORT FIELD

CONDITIONS:
Flaps 50°
Throttle Idle
Obstacle Clearance Speed Is 69 MCAS
No Wind
Paved, Level, Dry Runway

Notes: 1. Ground distances are estimated to be **approximately** 45% of total landing distance from 50 foot obstacle height.

PRESSURE ALTITUDE ft	STD. TEMP. °F	STD. TEMP. - 60°F DISTANCE TO CLEAR 50' OBSTACLE ft	STD. TEMP. - 40°F DISTANCE TO CLEAR 50' OBSTACLE ft	STD. TEMP. - 20°F DISTANCE TO CLEAR 50' OBSTACLE ft	STD. TEMP. DISTANCE TO CLEAR 50' OBSTACLE ft	STD. TEMP. + 20°F DISTANCE TO CLEAR 50' OBSTACLE ft	STD. TEMP. + 40°F DISTANCE TO CLEAR 50' OBSTACLE ft
SL	59	1008	1043	1079	1114	1150	1185
2000	52	1050	1088	1126	1164	1202	1240
4000	45	1095	1136	1177	1218	1259	1299
6000	38	1145	1189	1233	1277	1320	1364
8000	31	1199	1246	1293	1340	1387	1434

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MAXIMUM RATE OF CLIMB
MAXIMUM WEIGHT 2000 LBS
CLEAN CONFIGURATION

CONDITIONS:
Flaps Up
Full Throttle
Mixture Rich

NOTE:
Mixture leaned above 3000 feet for maximum RPM.

PRESS ALT FT	STD. TEMP. °F	CLIMB SPEED MCAS	RATE OF CLIMB - FPM					
			STD. TEMP. TEMP. - 60°F	STD. TEMP. TEMP. - 40°F	STD. TEMP. TEMP. - 20°F	STD. TEMP.	STD. TEMP. TEMP. + 20°F	STD. TEMP. TEMP. + 40°F
S.L.	59	73	832	806	780	756	733	712
2000	52	72	733	707	682	658	635	613
4000	45	71	635	608	583	559	536	514
6000	38	69	536	509	484	460	437	415
8000	31	68	437	410	385	361	338	316

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TAKEOFF RATE OF CLIMB
MAXIMUM WEIGHT 2000 LBS
MAXIMUM TAKEOFF FLAPS

CONDITIONS:
Gear Down
Flaps 25°
Full Throttle
Mixture Rich

NOTE:
Mixture leaned above 3000 feet for maximum RPM.

PRESS ALT FT	STD. TEMP. °F	CLIMB SPEED MCAS	RATE OF CLIMB - FPM					
			STD. TEMP. TEMP. - 60°F	STD. TEMP. TEMP. - 40°F	STD. TEMP. TEMP. - 20°F	STD. TEMP.	STD. TEMP. TEMP. + 20°F	STD. TEMP. TEMP. + 40°F
S.L.	59	66	710	685	662	640	620	600
2000	52	65	620	595	572	550	529	509
4000	45	64	529	505	482	460	439	419
6000	38	63	439	415	392	370	349	329
8000	31	62	349	325	302	280	259	239

BALKED LANDING RATE OF CLIMB
MAXIMUM WEIGHT 2000 LBS
MAXIMUM LANDING FLAPS

CONDITIONS:
Gear Down
Flaps 50°
Full Throttle
Mixture Rich

NOTE:
Mixture leaned above 3000 feet for maximum RPM.

PRESS ALT FT	STD. TEMP. °F	CLIMB SPEED MCAS	RATE OF CLIMB - FPM					
			STD. TEMP. TEMP. - 60°F	STD. TEMP. TEMP. - 40°F	STD. TEMP. TEMP. - 20°F	STD. TEMP.	STD. TEMP. TEMP. + 20°F	STD. TEMP. TEMP. + 40°F
S.L.	59	63	531	510	490	470	452	434
2000	52	62	452	430	410	391	372	355
4000	45	61	372	351	330	311	293	275
6000	38	60	293	271	251	232	213	196
8000	31	59	213	192	171	152	134	116

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WIPAIRE, INC.

• MANUFACTURERS OF WIPLINE FLOATS & SKIS
• SPECIALISTS IN AIRCRAFT MODIFICATION

1700 Henry Avenue - Fleming Field
South St. Paul, MN 55075
651-451-1205

WEIGHT AND BALANCE REPORT
and
EQUIPMENT LIST REVISION

Make: PIPER **Serial Number:** 18-6105

Model: PA-18 150 **Registration Number:** N8177D

Date: 11/16/2006 **Prepared by:** PAUL G DAUPHINAIS
for Wipaire CRS RJWR390K

ITEM	WEIGHT	ARM	MOMENT
ACTUAL WEIGH			
MAIN SCALE	1,526.0	9.0	13,734.0
RH TARE WT	-25.0	-56.8	1,419.0
LH TARE WT	-25.0	-70.8	1,756.0
Totals	1,476.0	11.5	16,909.00

FLOATPLANE WEIGHT

Max Wt.	2,000 lbs.
Empty Weight	1,476.0 lbs.
Empty Weight C.G.	11.46 ins.
Useful Load	524.0 lbs.

WIPAIRE, INC.

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• SPECIALISTS IN AIRCRAFT MODIFICATION

www.wipaire.com

1700 Henry Avenue - Fleming Field
South St. Paul, MN 55075
651-451-1205

WIPLINE MODEL 2100 / 2350 FLOAT

SERVICE MANUAL

AND

INSTRUCTIONS FOR CONTINUED AIRWORTHINESS

REVISED JUNE 25, 2008

WIPAIRE, INC.

1700 HENRY AVENUE – FLEMING FIELD

SOUTH ST. PAUL, MN 55075

PHONE: (651) 451-1205 FAX: (651) 451-1786

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LOG OF REVISIONS

REV	PAGES	DESCRIPTION	DATE
A	12, 23	Added an inspection time limit and tolerances for the Nose Block Track wear.	4/18/06
B	38-40	ADDED KEEL SPLICE REPAIR & FIGURES	6/30/06
	5-7	ADDED TABLE OF CONTENTS AND RENUMBERED ALL PAGES	6/30/06
C	17-19	NEW INSTRUCTIONS TO CHECKLIST & CHANGED FORMAT TO INCLUDE MECH. SIGNATURE & RT. LT. FLOAT	10/5/06
D	28-30, 23, 46-53	Altered Checklist format with INSP. Sign-off. Added hydraulic actuator rebuild instructions to pg 23. Added weighing info.	5/1/08
E	12,13 20,27, 28	Sections 5.2 instructions, 6.1 instructions, 7.4 instructions	6/25/08

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INTRODUCTION

This manual describes the general service and maintenance for the float, hull, gear systems, installation, and control parts. For service and repair not covered by this manual, contact the float factory.

The service products referred to throughout this manual are described by their trade name and may be purchased from the float factory Parts Department.

To contact Wipaire for service assistance or parts sales, call or write:

Wipaire, Inc.
1700 Henry Avenue – Fleming Field
South St. Paul, MN 55075
Telephone: (651) 451-1205
Fax: (651) 451-1786

1. General

The model 2100/2350 seaplane or amphibious float is an all aluminum-constructed float with watertight compartments. The actual displacement in fresh water for each float is 2323 pounds (model 2100) and 2570 pounds (model 2350) buoyancy for the seaplane and 2185 pounds (model 2100) and 2432 pounds (model 2350) buoyancy for the amphibian. The amphibian float is geometrically the same as the seaplane except for the addition of landing gear and internal structure for the gear.

The water rudder system is cable operated with ball bearing pulleys. Water rudder cables tie into the existing aircraft rudder system.

The main landing gear has a 5.00 x 5 6-ply tire and the nose landing gear has a 2.50 x 4 4-ply tire. The gear system is hydraulically actuated and driven by one reversible electric pump. Brakes are hydraulic and have a caliper on each main wheel.

Steering on land is accomplished by differential braking. The nose wheels are full castering.

Access to the float interior is accomplished by removing covers on the top deck, side skins and two covers inside the wheel well. When necessary, water inside the float hulls may be removed through pumpout cups located on the outboard edge of each float top skin.

2.0 **FLOAT HULL MAINTENANCE**

2.1 General

The float structure side and top skins are 6061-T6 and forward and aft bottom skins are 2024-T3 aluminum sheet and 6061-T6 extrusions. Skins are alodined and primed after being cleaned and acid-etched. Exterior is finished with an enamel color paint, or equivalent.

2.2 Cleaning

The outside of the float should be kept clean by washing with soap and water, with special care taken to remove engine exhaust trails, water line marks, and barnacle deposits as these are all linked to corrosion. After saltwater operation, washing with fresh water should be done daily with special attention to hard-to-reach places, such as seams, wheel well, etc. The float interior should be flushed if salt water enters the compartments; it's easy to tell by the smell inside the float lockers. At night or when the floatplane is in storage, the inspection and/or baggage covers should be opened so the interior has a chance to dry out.

THE ABOVE CLEANING TECHNIQUES ARE VITAL FOR KEEPING CORROSION TO A MINIMUM. SALTWATER OPERATIONS ARE STRONGLY LINKED TO CORROSION AND MUST BE ADDRESSED PROACTIVELY.

2.3 Hard Landing and Damage Investigation

After a thorough cleaning of the damaged area, all structural parts should be carefully examined to determine the extent of damage. Frequently, the force causing the initial damage is transmitted from one member to the next, causing strains and distortions. Abnormal stresses incurred by shock or impact forces on a rib, bulkhead, or similar structure, may be transmitted to the extremity of the structural member, resulting in secondary damage, such as sheared or stretched rivets, elongated bolt holes, or canned skins or bulkheads. Points of attachment should be examined carefully for distortion and security of fastenings in the primary and secondary damaged areas at locations beyond the local damage.

3.0 CORROSION

Corrosion is a reaction that destroys metal by an electrochemical action that converts metal to oxide. Corrosion is accelerated when in contact with dissimilar metals such as aluminum and steel, or any material which absorbs moisture like wood, rubber, or dirt.

The primary means of detection of corrosion is visual. The most obvious sign is a corrosive deposit of white powder. Other signs are discoloration of the metal surface or bubbles and blisters under the painted surface. Light corrosion may be removed by light hand sanding or chromic acid. Moderate and severe corrosion (blistering, flaking, and pitting) may be removed by heavy sanding or grinding, and applying chromic acid. No more than 1/3rd the thickness of skin material should be removed before complete replacement or reinforcement of an area is necessary.

After removing the corroded area, restore area to original finish (prime and enamel). BOESHIELD T9 or ACF-50 may also be applied to stop corrosion. Refer to manufacturer's instructions for application instructions.

Maintaining the float inside and outside finishes by washing after saltwater operations will help protect the float from corrosion. Periodically, all hardware should be covered with a waterproof grease, or paralketone. Under saltwater conditions, bolts should be removed at least once a year and grease reapplied to the shafts, heads and nuts.

4.0 FLOAT HANDLING AND JACKING

To jack the floats for servicing tires, brakes, or doing retraction tests, it is recommended that a floor type jack (1 ton minimum.) be used. These jacks are commonly used for auto repair. The jack should be positioned on the keel centerline approximately 12 inches forward of the step. The jack should contact the keel squarely and if room permits, slip a board between the jack and keel. Raise the float slowly, making sure the aircraft stays balanced. After raising, block up the keel in several places and lower the jack. Raise only one float at a time, with the opposite float landing wheels chocked. Position a sawhorse under main and after body keel to keep aircraft from tipping fore and aft.

For raising the aircraft for float installation and removal, use the lifting rings if provided or lift at front wing attach points. Aircraft may be lifted by spreader bars with a launching dolly. **WITH CAUTION,** lift on both spreader bars as close to float hull as possible.

5.0 RETRACT SYSTEM OPERATION AND MAINTENANCE

5.1 Description and Operation

Retraction and extension of the main and nose landing gear is effected by a hydraulic actuation system shown schematically in figure 5-1.

The gear system is hydraulically actuated and driven by one reversible electric pump.

A pressure of between 500 psi and 700 psi in the up and down position is maintained in the supply line. When the pressure falls below 500 psi in the up and down position, the pressure switch activates the pump solenoid, providing power to the pump. When the pressure reaches 700 psi in the up and down position, the pressure switch deactivates the solenoid and the pump motor stops. Figure 5-2 shows the electrical schematic of the system. A check valve on the output side of the pump retains pressure in the system while the pump is off. The pump has an interval relief valve that directs oil back to the pump reservoir when the line pressure exceeds 800 psi. The system also has an internal relief valve to protect against thermal expansion when line pressure exceeds 1100 psi.

The selection of gear up or gear down is accomplished by a cockpit mounted control panel. Each float gear has individual indicator lights on the control panel allowing the pilot to confirm that each gear has fully retracted or extended.

At the top of each float deck just forward of the step, a visual indicator is provided for the main gear. Nose gear up and down may be determined visually for position.

An emergency hand pump is provided in case of total electric pump failure or loss of fluid. The reservoir has additional hydraulic fluid available only to the hand pump.

The main gear has an over-center lock in both up and down positions. Retraction takes place when pressure is exerted on the actuator piston driving the actuating arm along the slide track (see Figure 5-3). A reverse process effects extension. Gear position light proximity switches are closed when the cylinder piston (containing the magnetic material) is adjacent to the switch.

The nose gear has an over-center down lock. Retraction occurs when pressure is applied to the forward fact of the actuator piston and the carriage is drawn along the tracks in the nose box as shown in Figure 5-4. Gear position light proximity switches are closed when the piston containing the magnetic material has reached either end of its travel.

5.2 Adjustment/Test

Adjustment of the hydraulic actuator stroke is provided at the ends of the piston rods on the nose and main gear.

Nose:

The “gear down” position is set by adjusting the cylinder rod end so the over-center knuckle (brass) rollers bottom out in the Nose Fork Tracks without preload on the cylinder rod.

The gear up position does not require adjusting as long as the Up Stop has engaged the Up Stop Pin.

Mains:

With the Retract Arm disconnected from the Rod End, move the cylinder to the “gear up”(retracted) position using the aircraft pump. Then position the gear in the “gear up” position and hold in place through the top access hole in the float.

Align the hole in the Rod End Clevis with the hole in the Retract Arm. The hole in the clevis should be 1/32-1/16” below the hole in the retract arm. This adjustment must be accomplished by adding or removing washers under the rod end lock nut. The in and out adjustment of the rod end on the threads is not critical at this time as long as the lock nut is snug against the Rod End Clevis.

Again, using the aircraft pump, move the piston rod to the “gear down”(extended) position. Then position the gear in the “gear down” position and hold in place through the top access hole in the float.
Align the hole in the Rod End Clevis with the hole in the Retract Arm. Adjust the Rod End Clevis so that the hole in it is 1/32-1/16” above the hole in the retract arm and tighten the lock nut.

Nose and main gear proximity switches are set by sliding the mounting clips on the cylinders to a position such that the light goes out when the cylinder piston is about 1/8 inch from the bottomed position while traveling in the up direction. It should come on about 1/8 inch from the bottomed position while traveling in the down direction.

The system automatically bleeds, provided sufficient oil is maintained in the reservoir. To check the fluid level, fill the reservoir with hydraulic oil and cycle the gear. If the reservoir empties (i.e., fluid disappears in sight glass), stop the cycle by pulling the circuit breaker on the control panel. Fill the reservoir again and complete the cycle. Continue this procedure until the fluid level in the reservoir stabilizes (it will vary in level between up and down positions). If the fluid level continues to decline during gear cycles, check for external leaks. If pump cycles on and off during gear cycle, it may be necessary to select hand pump to “UP.” Cycle gear up with electric pump. Then select to gear “DOWN” on hand pump and cycle gear down with electric pump. Repeat if necessary. This manually bleeds system. NOTE: Fluid level in reservoir in “UP” position is full. “DOWN” position reservoir is half full. Don’t over fill in “DOWN” position.

5.3 Landing Gear Malfunction Procedures

Landing Gear Fails to Retract or Extend:

1, Battery Switch – ON
2. Landing Gear Switch – RECHECK IN DESIRED POSITION
3. Landing Gear Motor Circuit Breaker – CHECK IN
4. Hand Pump Position Selector – CHECK in NEUTRAL POSITION
5. Gear Lights – 4 BLUE for gear UP
   4 GREEN for gear DOWN
6. Gear Position – CHECK VISUALLY

If gear still in improper position:

7. Landing Gear Switch – RECYCLE
8. Landing Gear Motor – CHECK RED LIGHT ON
9. Airspeed – REDUCE to minimize airloads on gear

If pump is running intermittently, or gear is not moving:

10. Hand Pump Position Selector – PLACE IN SAME POSITION as Landing Gear Switch.

NOTE

Hand Pump Position Selector must be aligned for the **same** position as the Landing Gear Switch.

11. Gear Operation – VISUALLY VERIFY

If above procedure still fails to position landing gear as desired:

12. Landing Gear Motor Circuit Breaker – FULL.
13. Landing Gear Switch – DESIRED POSITION
14. Hand Pump Position Selector – PLACE IN DESIRED POSITION
15. Emergency Hand Pump – PUMP until resistance becomes heavy (may be 100 or more cycles)
16. Gear Position – CONFIRM VISUALLY

WARNING ! !

Do not attempt to land on water unless all four wheels are fully retracted.

17. Refer to Section 5.4 for more detailed troubleshooting.

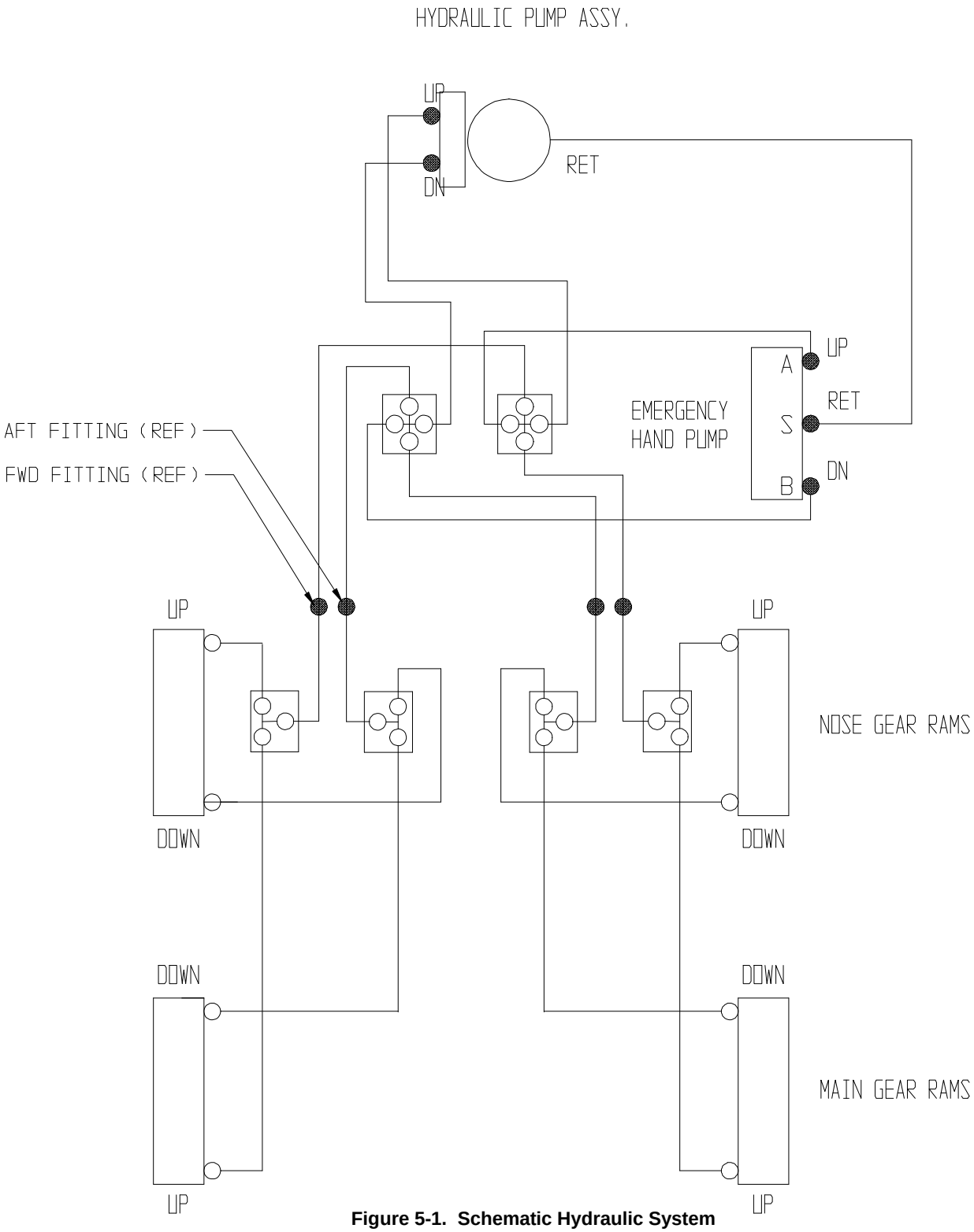


Figure 5-1. Schematic Hydraulic System

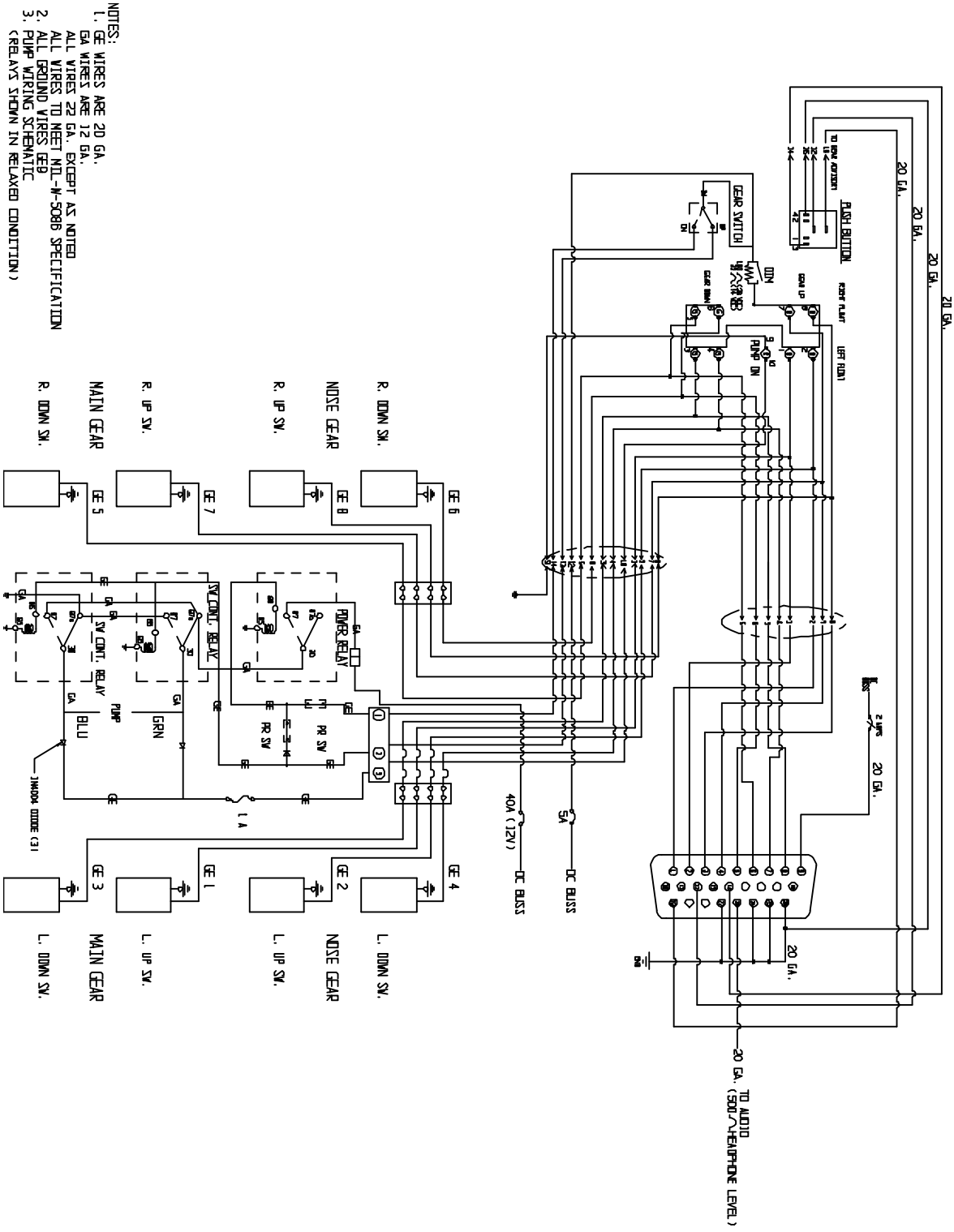


Figure 5-2. Schematic Electrical System

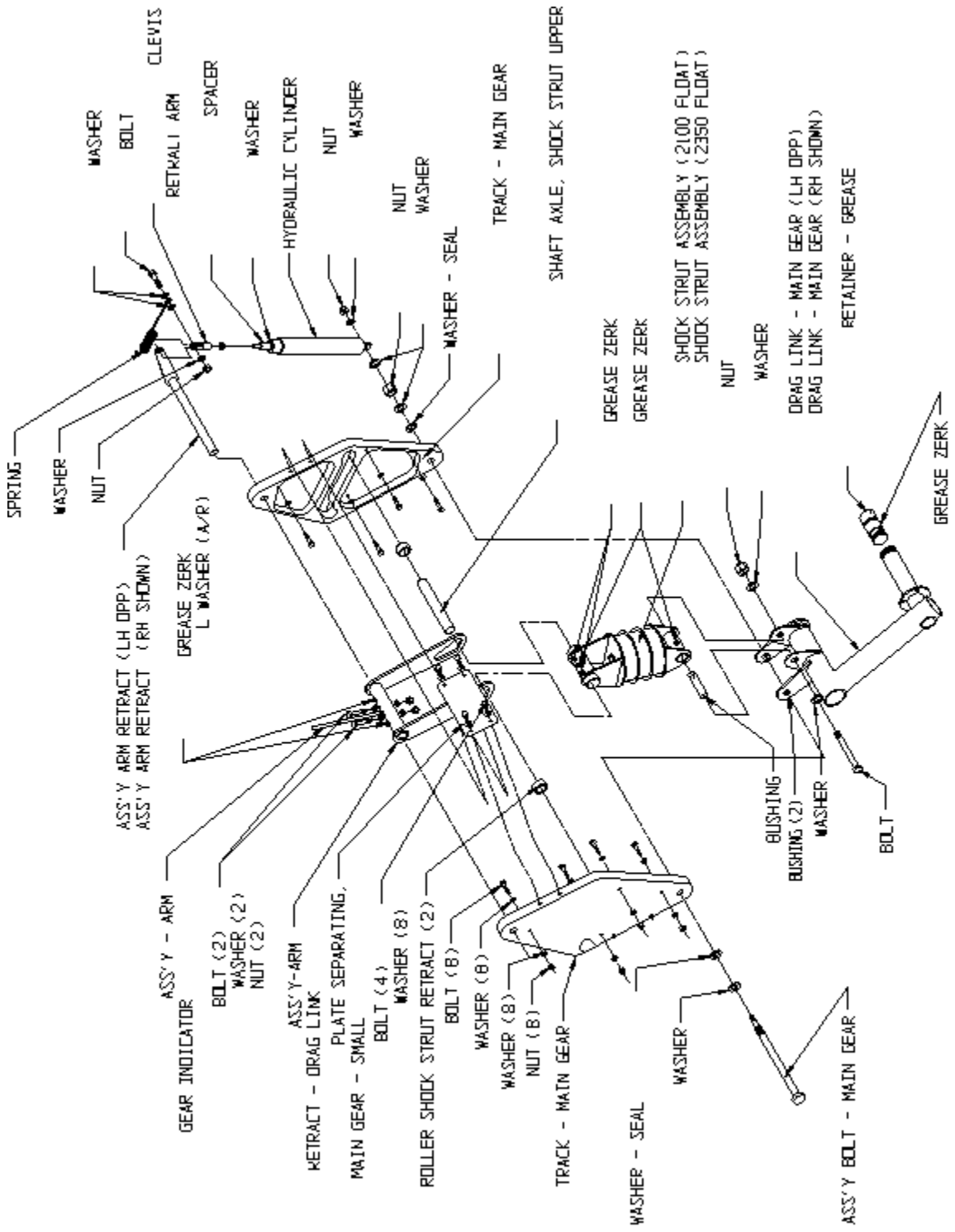


Figure 5-3. Main Gear Actuation

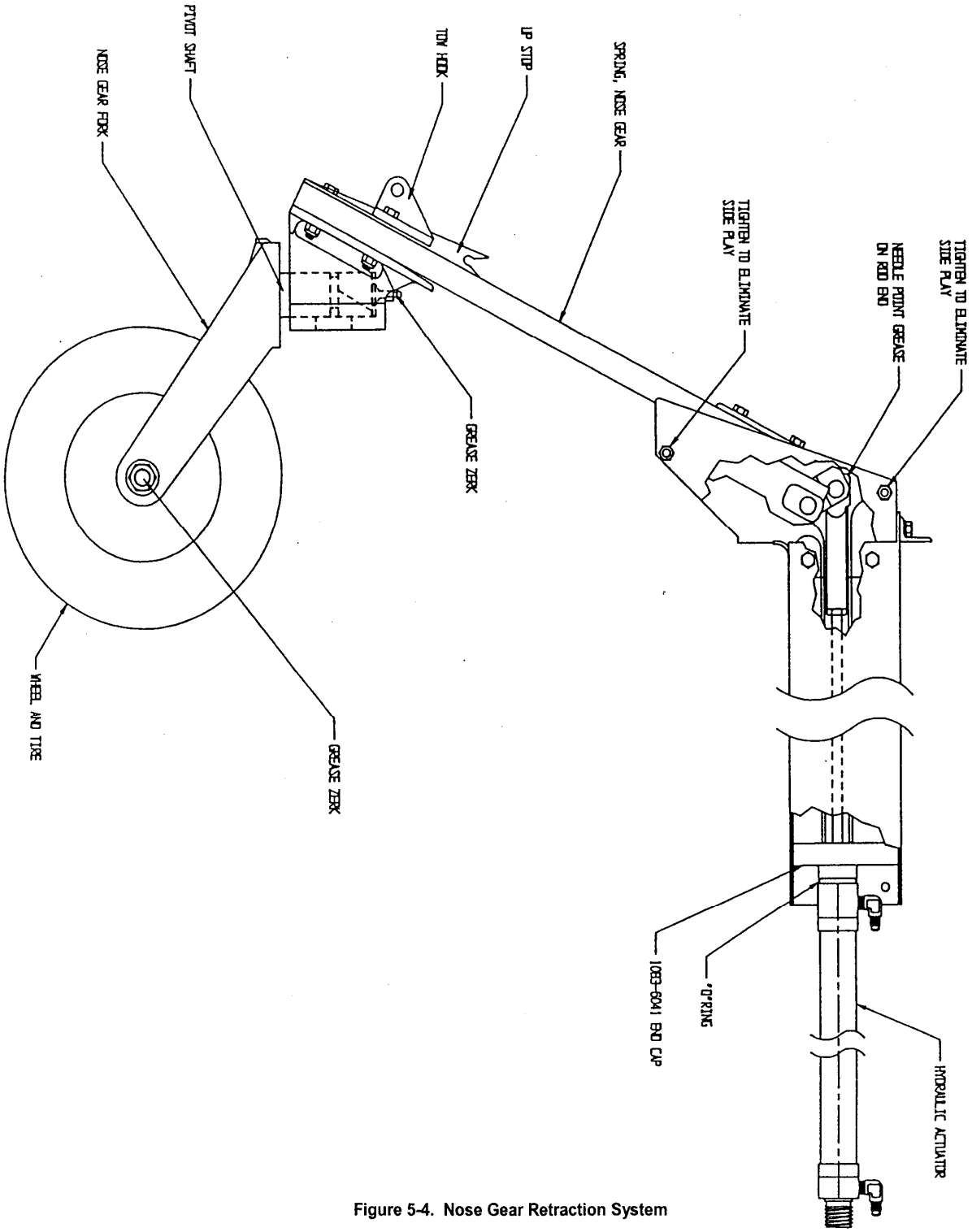


Figure 5-4. Nose Gear Retraction System

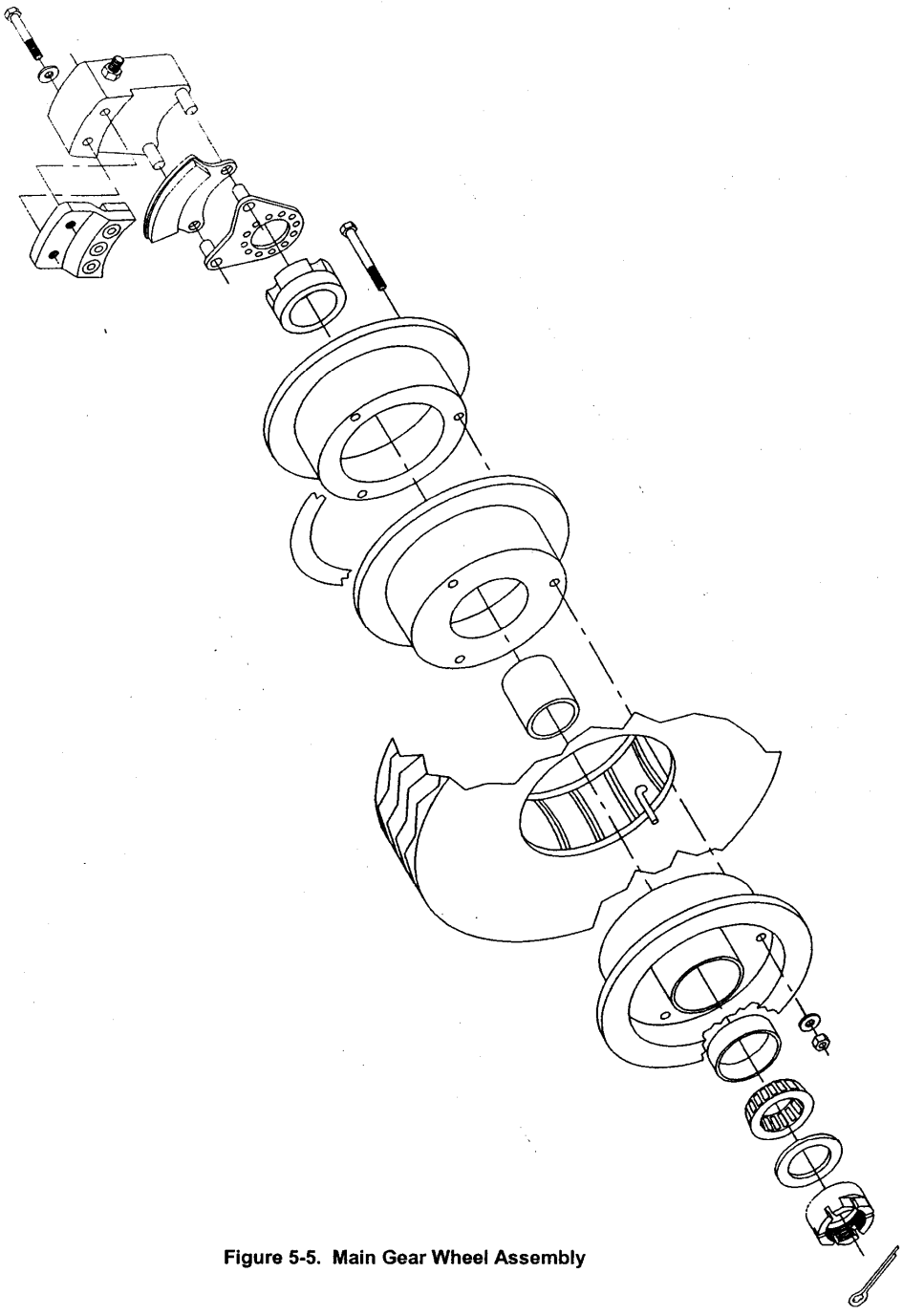


Figure 5-5. Main Gear Wheel Assembly

6.0 RETRACT SYSTEM OPERATION AND MAINTENANCE

6.1 Description and Operation

Retraction and extension of the main and nose landing gear is affected by a hydraulic actuation system shown schematically in Figures 5-1, 5-1B, 5-1C, or 5-1D.

The gear system is hydraulically actuated and driven by one reversible electric pump.

A pressure of between 500 psi and 700 psi in the down and up position is maintained in the supply line. When the pressure falls below 500 psi in the down position and 500 psi in the up position, the pressure switch activates the pump solenoid, providing power to the pump. When the pressure reaches 700 psi in the down position and 700 psi in the up position, the pressure switch deactivates the solenoid and the pump motor stops. Figure 5-2 shows the electrical schematic of the system. A check valve on the output side of the pump retains pressure in the system while the pump is off. The pump has an interval relief valve that directs oil back to the pump reservoir when the line pressure exceeds 800 +100/-0 psi. The system also has an internal relief valve to protect against thermal expansion when line pressure exceeds 1100 +100/-0 psi.

See Section 8 for disassembly, service and troubleshooting.

The system requires hydraulic oil (Mil-H-5606 Red). To check the fluid level, fill the reservoir with hydraulic oil and cycle the gear. If the reservoir empties (i.e., fluid disappears in sight glass), stop the cycle by pulling the circuit breaker on the control panel. Fill the reservoir again and complete the cycle. Continue this procedure until the fluid level in the reservoir stabilizes (it will vary in level between up and down positions). If the fluid level continues to decline during gear cycles, check for external leaks. If pump cycles on and off during gear cycle, it may be necessary to select hand pump to “UP.” Cycle gear “UP” with electric pump, then select gear “DOWN” on hand pump and cycle gear “DOWN” with electric pump. Repeat if necessary. This manually bleeds system.

NOTE

Fluid level in reservoir in “UP” position is full; “DOWN” position reservoir is half full. Don’t over fill in “DOWN” position.

A cockpit-mounted switch accomplishes the selection of gear up or gear down. Each landing gear has an individual indicator light on the selector head allowing the pilot to confirm that each gear has fully retracted or extended.

At the top of each float deck just forward of the step, a visual indicator is provided for the main gear. Nose gear up may be determined visually for position.

An emergency hand pump and selector valve is provided in case of total electric pump failure or loss of fluid. The reservoir has additional hydraulic fluid available only to the hand pump.

The main gear has an over-center lock in both up and down positions. Retraction takes place when pressure is exerted on the actuator piston driving the actuating arm along the slide track (refer to Figure 6-1). A reverse process affects extension. Gear position light proximity

switches are closed when the cylinder piston (containing the magnetic material) is adjacent to the switch.
The nose gear has an over-center down lock. Retraction occurs when pressure is applied to the forward face of the actuator piston and the carriage is drawn along the tracks in the nose box as shown in Figure 7-1. Gear position light proximity switches are closed when the piston containing the magnetic material has reached either end of its travel.

6.2 Service Schedule

As coded in the Inspection Time Limits chart in this section, there are items to be checked each 25, 50, 100, and 200 hours. Also, there are notes on special items which may require servicing at more frequent intervals.

- When conducting an inspection at 25 hours, all items marked for 25 hours would be accomplished.
- When conducting an inspection at 50 hours, the 25 and 50-hour items would be accomplished.
- When conducting an inspection at 100 hours, the 25, 50, and 100-hour items would be accomplished.
- When conducting an inspection at 200 hours, the 25, 50, 100, and 200-hour items would be accomplished.
- A complete inspection (Annual Inspection) would include all 25, 50, 100, and 200-hour items.

When servicing float hull and amphibian components, below is list of recommended lubricants and “protection” products. This lists products used by Wipaire during assembly of the floats.

There may be equivalent products that are just as satisfactory for protection. It is recommended if trying different products, to inspect them frequently so as to determine their effectiveness.

Protection of nuts, bolts, hydraulic lines or metal surfaces

Zip D-5029NS Corrosion Inhibiting Compound
Zip Chemical Company

CRC – SP400 Soft Seal
CRC Industries

General Lubricants

LPS 1, LPS 2 and LPS 3
LPS Industries

Wheel Bearings

HCF Grease, P/N 605
HCF Industries

Rust Protection

Boeshield T9 Rut Protection
Boeing Company

ACF-50 Rust Protection

Float Sealant

890 B2 or B4
Pro Seal Company

1422 B2, B4 or B6
Pro Seal Company

RTV Silicones
General Electric

SIKAFLEX 201 or 252
Sika Manufacturing

Telflon Spray

6P-730A
Comet Industries

Hydraulic Fluid

Mil-H-5606

As general inspection guidelines, each of the following areas should be inspected for their own unique attributes:

Movable Parts

For lubrication, servicing, security of attachment, binding, excessive wear, safetying, proper operation, proper adjustment, correct travel, cracked fittings, security of hinges, defective bearings, cleanliness, corrosion, deformation, sealing, and tension.

Fluid Lines and Hoses

For leaks, cracks, dents, kinks, chafing, security, corrosion, and deterioration.

Metal Parts

For security of attachment, cracks, metal distortion, broken welds, corrosion, condition of paint, and any other apparent damage.

Wiring

For security, chafing, burning, defective insulation, loose or broken terminals, corroded terminals.

Bolts in Critical Areas

For corrosion, correct torque when installed, or when visual inspection indicates a need for a torque check.

Some additional general maintenance areas are as follows:

Nose and Main Gear Tracks
Clean and lubricate with a dry teflon coating spray.

Joints
Spray all joints with light penetrating oil such as LPS 3 to ensure lubrication at all times.

Electrical Connections
Apply SP-400 SOFT SEAL or LPS 500 to all electrical connections to prevent corrosion.

Hydraulic Fluid
For use in all hydraulic systems, including brakes: MIL-H-5606.

7. MAIN GEAR REMOVAL AND OPERATION

7.1 Removal and Disassembly of Main Gear

1. Jack and block aircraft per Section 4. You may do one gear at a time or both if float is properly blocked
2. After load is off landing gear, pull circuit breaker and move hand pump selector to up, then to down and back to neutral to relieve hydraulic pressure.
3. Remove all three (3) access covers: 1 top and 1 each side of wheel well area.
4. Remove putty around side access jambs.
5. Remove brake caliber. Do not disconnect hydraulic lines so it's not necessary to bleed on reinstall.
6. Remove axle cotter pin, wheel nut and tire (refer to Figure 6-3).
7. Through top access, remove gear indicator shaft and cable.
8. Through outboard side access, remove upper bolt on hydraulic cylinder.

NOTE
Position of tension spring

9. Remove ground electrical wire screw.
10. Remove bolt on lower end hydraulic cylinder.
11. Use tie strap to tie cylinder forward for ease of bolt removal of gear.
12. Through top access, bring gear to the up lock position by moving gear by hand.
13. Under the float, remove cotter pin on coupling nut (2).

NOTE
Before removing, mark nut inboard or outboard for ease of reinstalling.

14. Hold coupling nut with 1 inch wrench while removing bolt on outboard side, then inboard side.

NOTE
Just remove coupling nut, leave bolts through gear tracks for now.

15. Through top access, unlock gear and by hand move to the down position.
16. Under the float remove bolt on drag link holding the lower shock strut end.

17. Through side access finish removing main drag link 5/8-inch bolts and remove drag link.
18. Through top access, remove two (2) ¼ inch diameter bolts on retract yoke.
19. From outboard access remove retract arm by pulling outboard.
20. From outboard and top access, remove four (4) 3/16 inch diameter bolts holding track to side panels.
21. From inboard access, remove four (4) 3/16 inch diameter bolts holding track to side panels.
22. From under float, slide out the entire track assembly. Position on bench.
23. Remove shock strut assembly from track assembly by spreading track panels apart. (Leave track spreader plate intact.)
24. Clean and inspect track.
25. To remove shaft from upper shock strut, remove the two (2) outside grease zerk fittings.
26. For shock strut service, shock strut must be compressed before disassembly.

NOTE
Shock strut maybe returned to the factory for service.

27. Clean and inspect all parts.

7.2 Installation and Assembly of Main Gear

1) Assemble track assembly before installing in float.
2) Lay shock strut on bench with grease zerk facing up.
3) Install retract yoke to shock strut upper end with roller shaft.

NOTE
Holes in shaft to match holes in shock strut bushing. Grease zerks position shaft to shock strut bushing.

4) Install bushing to lower shock strut. Grease.
5) Grease shaft and install rollers to each end.

NOTE

Radii on bushings to be on outboard side

6) Install tracks over this assembly.

NOTE

Position of tracks, retract yoke and shock strut with each other is important.

7) Before installing track assembly clean out wheel well area of dirt, excess grease, etc.
8) Reinstall track assembly from bottom of float.

NOTE
Position of track spreader plate. It goes to the up position.

9) Position track assembly in wheel well area and start lower 5/8-inch diameter removed in step 16, one (1) each side.

NOTE

This positions track assembly. Do not install coupling nut or tighten at this time.

10) Pivot track around 5/8-inch bolts to align 3/16-inch bolt and each side to wheel well. Do not tighten.
11) Temporarily install retract arm through to 5/8-inch hole in tracks **without** going through retract yoke.
12) Tighten all 3/16-inch bolts four (4) each side on tracks.
13) After tightening 3/16-inch side bolts eight (8) remove retract arm and install through retract yoke, upper bushing.
14) Reinstall two (2) ¼-inch diameter bolts in retract yoke to retract arm and tighten (refer to Figure 6-9).

NOTE

Temporarily tie shock strut to the up position so it's not in the way when reinstalling drag link clean and inspect drag link. Install drag link so shock strut lugs are up. Install one (1) 5/8-inch diameter bolt on each side.

15) Untie shock strut and attach to drag link 5/8-inch bolt.

NOTE

Do not over tighten, lugs will bend.

16) Position by hand gear to the "Up" lock.
17) Install coupling nut.

NOTE

Nut must be installed in same position as removed or cotter keyholes will not line up.

18) Tighten outboard nut first and align cotter keyhole. Tighten inboard bolt and align cotter keyhole. Install two (2) cotter keys.
19) Cycle by hand from top access up to down. Inspect and feel for any binding and rollers going to each stop (end of track).
20) Reinstall tire and brake.

NOTE

Cotter key axle and safety wire brake bolts.

21) Through access holes clean out bottom of float.
22) Grease all zerk fittings and head of nuts on all bolts exposed.
23) Install lower cylinder 3/8-inch bolt.

NOTE

Position of washers (one (1) each side of cylinder) and remove any excess Loktite from hole in 5/8-inch bolt head before installing 3/8-inch bolt. Apply to Loktite 3/8-inch bolt before installing. Visually inspect bolt for proper installation.

24) Reconnect ground wire screw.
25) If cylinder was replaced, cylinder must be reindexed at this time. Retract cylinder using aircraft pump to gear down.
26) From top access hold by hand in gear down position. Adjust rod end so its 1/16-inch down from retract armhole (1/16-inch cushion) (refer to Figure 6-10).
27) Use aircraft pump to gear up. Rod end should be 1/16-inch below hole in retract arm. (1/16-inch cushion.)

NOTE

Add spacer, washers under jam nut as necessary to achieve 1/16-inch cushion.

28) Install upper cylinder bolt to attach cylinder rod end to retract arm, attach tension spring (refer to Figure 6-4).
29) Check retract for operation by aircraft hydraulic system.
30) Set gear position switch by sliding bracket on outside of hydraulic cylinder body by running gear to down position, slide switch bracket up so lights (green) are illuminated on selector head (refer to Figure (6-12).
31) By running gear to up position, slide switch bracket down so lights (blue) are illuminated on selector head.

NOTE

If lights have a double flash (on-off-on) move switch brackets further to outer ends so lights come on just once.

32) After switch brackets are positioned, apply bead of RTV silicone to secure bracket to cylinder body.
33) Install indicator rod and cable through top access.
34) Grease all zerk fittings, bolt heads, nuts, bolt shafts that are exposed. Grease wheel bearings.
35) Final gear check and inspection.
36) Caulk and replace side access covers.
37) Install top indicator cover.

7.3 Disassembly of Shock Strut

Shock strut requires no maintenance except if urethane blocks seem sloppy or spin around easily. To dissemble, remove cotter pin in top retaining pin and remove pin. If replacing urethane blocks, pressure must be applied by arbor press or vice to compress strut and install retaining pin. Assemble in reverse order of removal or Figure 5-3.

7.4 Servicing Hydraulic Actuator Cylinders (Nose or Main Actuators)

Wipaire, Inc. has created a new design to replace the previous, unserviceable main and nose gear actuators for the 2100, 2350, 3000 and 3450 amphibious floats and is detailed in Service Letter 97 available on our website or from our customer service department. The actuators are fully serviceable.

The older style, non-repairable units can be identified by the stainless steel (shiny) outer cylinder with non removable aluminum end caps. If these units leak or will not hold pressure they should be replaced with new units. The new units will be the repairable type. The sealed units can also be upgraded to the repairable type at any time in accordance with Service Letter #97.

Repairable units: All new products will have the repairable type cylinders. These can be identified by their all aluminum construction and grey color. These units can be disassembled and repaired according to the following instructions.

Repair Kits include all replacement O-rings and Quad-rings, and Rod Wiper

2000 Series Floats

	Cylinder Part Numbers	Repair Kit Number
Nose:	1002571	1002578
Main:	1002574	1002578

If servicing beyond the usual cleaning and inspection, use Section 6 & 7 & 8 to remove the main and nose gears respectively. Once cylinders are removed from the floats:

1. The end caps must be removed; they are secured with medium strength Lock-Tite. Always clamp the tube in such a way as to not damage or deform the outer cylinder.
2. Once the end caps are removed, remove the rod and piston from the main cylinder.
3. Remove the two quad rings off the piston, then remove the O-rings off the end caps.
4. Remove the two O-rings from the front rod end cap located on the inside portion of the rod end cap and the plastic wiper ring. All parts must be thoroughly cleaned of any residue of Lock-Tite and hydraulic fluid.

NOTE

Be sure to look at all seals closely so they can be re-installed correctly.

Reassembly

1. To reassemble, first make sure you are using Mil-H-5606 hydraulic fluid and pre-lubricate all the new quad and O rings (not the wiper) with it.
2. Thread the end cap onto the cylinder tube a couple threads. Waiting to add a drop of medium strength Loktite until this point helps to keep it from contaminating the cylinder. Then finish carefully tightening the end cap.
3. Following that, slide the piston down into the cylinder being careful of the quad rings Check the top of the cylinder when this is done for flakes of rubber to indicate **any** damage from installation.

4. Clean the threads and install the quad rings into the rod end cap.

NOTE

Make sure that quad rings are not twisted and are Seated in the grooves. If they are compromised in Any way, they will not seal or hold pressure properly.

5. Install the new seal ring and lubricate all the quad and O-rings with hydraulic fluid and insert the threaded end of the rod, making sure of the end of the rod is clean and free of any sharp edges that will damage the quad ring.
6. Once this is slid past the flats in the threaded ends, check again for any evidence of seal damage by looking for flakes of rubber. If there is **ANY** damage to any of the seals, they must be replaced.

NOTE

When sliding the rod end cap over the threaded rod, SLOWLY work the rod end cap down on the rod; You should feel the rod pass thru each quad ring.

7. **Thread the rod end cap into the cylinder tube. Start threads and then add a drop of Loktite on the remaining threads and tighten both ends.**
8. **On the main gear actuators, the in and out fittings must be indexed so that they Face approximately the same direction. If adjustment, add or remove shims under the end cap.**

7.5 Hand Pump Operation

For normal operation (electrical power pack) the handle is in the neutral position (handle pointed to the neutral position.) If electrical pump should not operate, select to gear up (handle pointed forward) or gear down (handle pointed aft). Insert stowable handle in pump and pump gear to desired position. If pump should leak, remove snap ring under handle and pull out inner cylinder. Replace “O” rings and reinstall.

7.6 Gear Selector

The gear selector is an electrical switch which changes pump direction of the electro power pack for gear up or down. The red light on panel indicates the pump is running. The four (4) green lights indicate the landing gear is down. The four (4) blue lights indicate the gear is up for water landing. The top two lights of each cluster refer to the nose gear position. The bottom two refer to the main gear.

BLUE - GEAR UP “WATER”

GREEN - GEAR DOWN “LAND”

CAUTION ! !
Do not land on water with gear in extended position. Aircraft will nose over.

7.7 Main Wheels and Brakes

Grease zerks are provided on all wheels and bearings and should be greased every 25 hours or after an extended period of time in the water. Water/heat resistant grease is recommended.

The brakes need no special care other than to maintain the brake disc free of rust, which causes premature brake lining wear. Bleeding is carried out in the usual manner from the bottom up.

Main wheel tires are standard 5.00 X 5, 6-ply Type III aircraft tires, inflated to 50 +/- 5 psi. (Refer to Figure 5-5.)

7.8 Visual Position Indicators Main and Nose Gear

In addition to position lights on selector head, gear position should be visually inspected before landing. Check nose gear positions by looking at gear to determine position. Main gear has a position indicator rod on the float top deck. Check position of both right and left rod before landing.

8. NOSE GEAR

8.1 Description

The nose gear consists of scotchply fiberglass beams that are attached at the bottom to castoring blocks. A nylon thrust washer is located on top of the castoring pin. To disassemble, remove ¼ diameter pin on side of pivot block.

8.2 Service Schedule

The nose gear pivot assembly should be cleaned and greased every 25 hours or more frequently whenever in water for extended period of time.

The nose wheels contain grease zerks for the wheel bearings. They should be greased every 25 hours.

Nose tires are standard 2.50 x 4, 4-ply, inflated to 50 +/- 5 psi.

8.3 Nose Trolley Removal From Box Assembly

1) Jack and block aircraft per Section 4.
2) Remove top most forward access cover.
3) Remove round inspection cover on nose box top from above access (refer to Figure 7-2).
4) With hand pump, retract gear partially so rod end of cylinder is exposed in round access cover on nose box top.
5) Loosen jam nut and unscrew cylinder rod end from end of cylinder.

6) Nose gear assembly now may be removed from nose by pulling complete nose gear down from nose box.
7) Clean and inspect nose box tracks for wear.
8) Replace or inspect trolley axles and nylon blocks on nose gear trolley.
9) Assemble in reverse order of removal and 7.3.

8.4 Reassemble Nose Trolley to Nose Box

1) If installing rod end and trolley link to trolley, note position of grease hole, it has to be positioned up (refer to Figure 7-4).
2) Before inserting trolley in nose box, take care to position nylon slide blocks. Position as noted on Figure 7-1 and Figure 7-4.
3) Slide trolley into nose box and reconnect to cylinder (refer to Figure 7-2).
4) After above has been accomplished, the down lock has to be adjusted by lengthening or shortening cylinder rod end. Adjust so two (2) rollers on the trolley link axle sit in the nose fork down stop slots.
5) Set jam nut on cylinder rod end.
6) Bring gear to down and locked position and set side play adjustment. These are the two (2) long ¼ inch bolt that (refer to Figure 7-3) are horizontal through the nose fork. Adjust to 3/32 maximum side play. Do not over-tighten bolts to avoid gear binding.
7) Reinstall cover on Figure 7-2.
8) Set proximity switches (or check) so when gear is down green lights on selector head are on. When gear is up blue lights are on. Set by sliding switch brackets on cylinder shaft. When set apply RTV silicone to secure to cylinder.

8.5 Removal of Nose Wheel Fork From Pivot Assembly

1) Remove ¼ inch bolt.

NOTE

This is a heat-treated bolt.

2) Entire pivot shaft on nose fork will drop down for service.
3) Assemble per Figure 7-1.
4) Axle bolt is modified for grease service. A special anti-rotation washer is under bolt head to keep axle from turning.

8.6 Nose Box Removal from Float

1) Nose gear must be removed 7.2.
2) Remove the eight (8) ¼ inch bolts from nose bulkhead. (Plate nuts are on inside of nose bulkhead.)
3) Hydraulic cylinder to be removed by unscrewing from back nose box flange.

NOTE

This cylinder does not need to be removed
To remove the nose box assembly from the float.

NOTE

Keep washers on cylinder for reinstallation.

4) Remove two (2) bolts holding nose box to float bulkhead angles.
5) Slide entire nose box forward.

NOTE

Nose box may be removed by just removing hydraulic lines, elbow fittings, and proximity switches. Then slide box out with cylinder attached.

8.7 Nose Box Track Wear

Due the wear over time the roller/slide block places on the track as the gear are retracted, the block needs to be measured for the amount of wear. The tolerance for wear is .020 inches. If the wear is, or is less than the limit, it can still be used. If the wear in the track is greater than .020 inches, the block must be replaced. This check is to be done every 200 hours and is part of the maintenance checklist.

On the 2100 & 2350 Series Floats Gear Track P/N 21A07349 (-003 LT -004 RT)

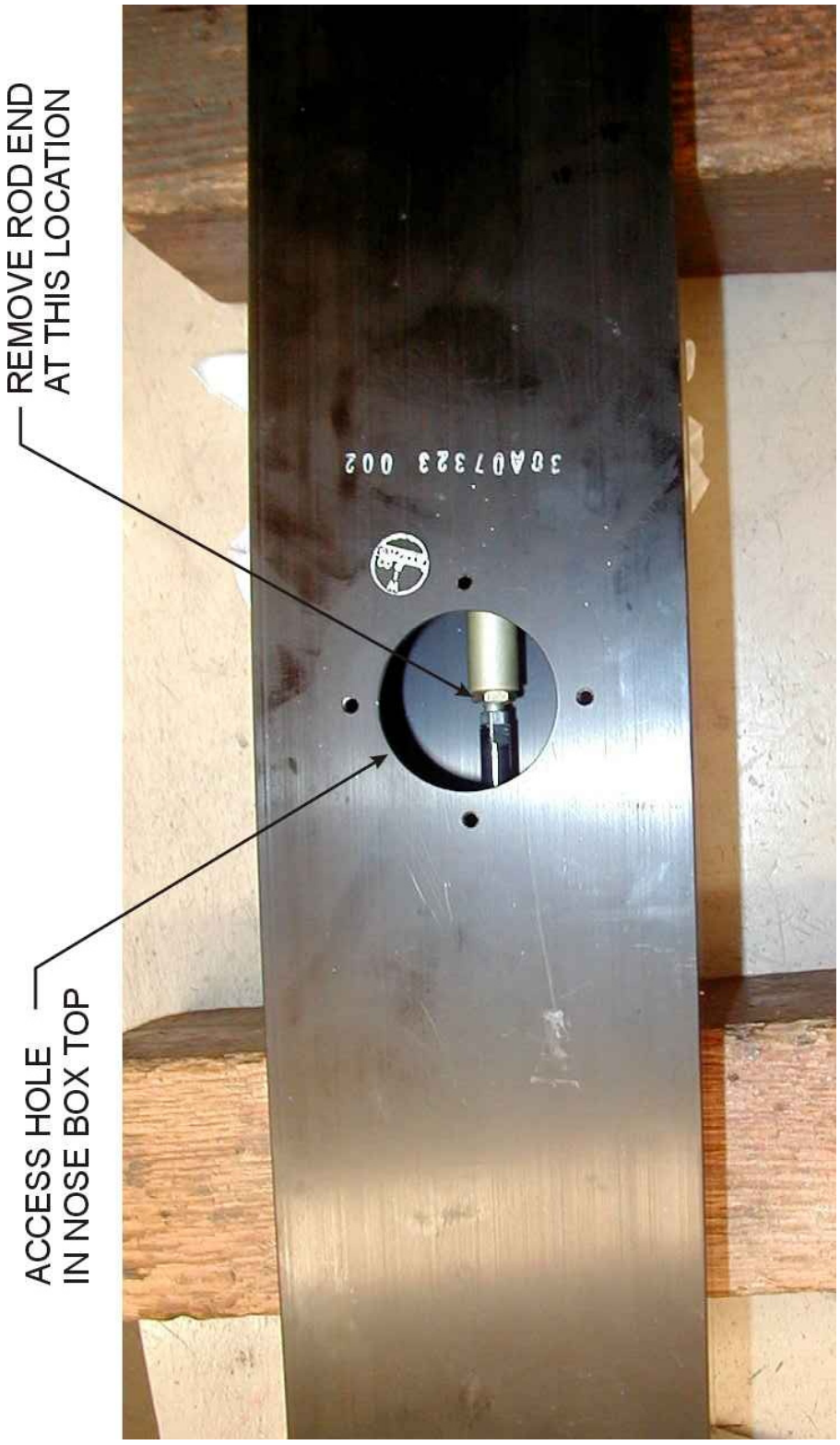


Figure 7-2. Nose Box Access Location

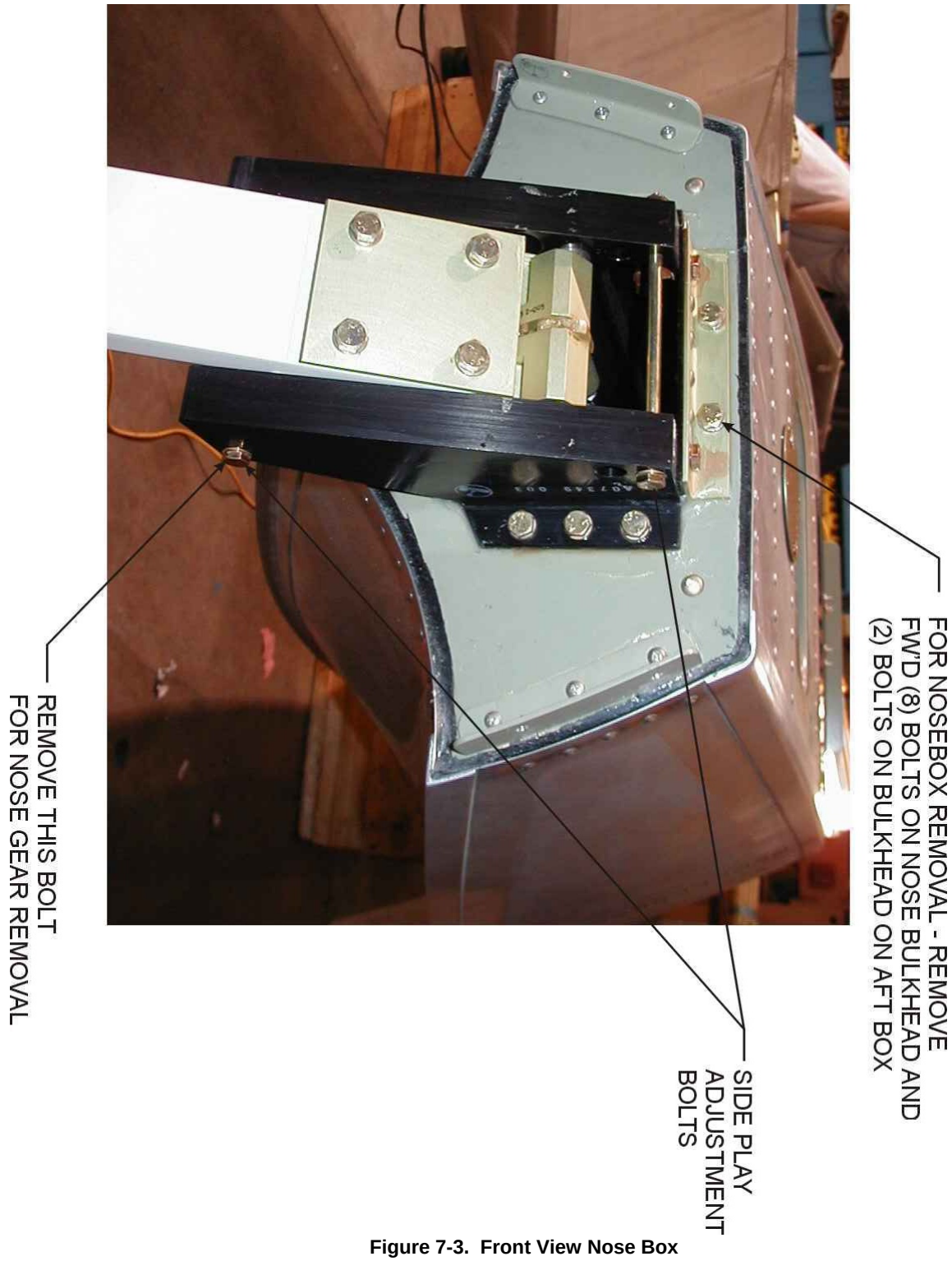


Figure 7-3. Front View Nose Box

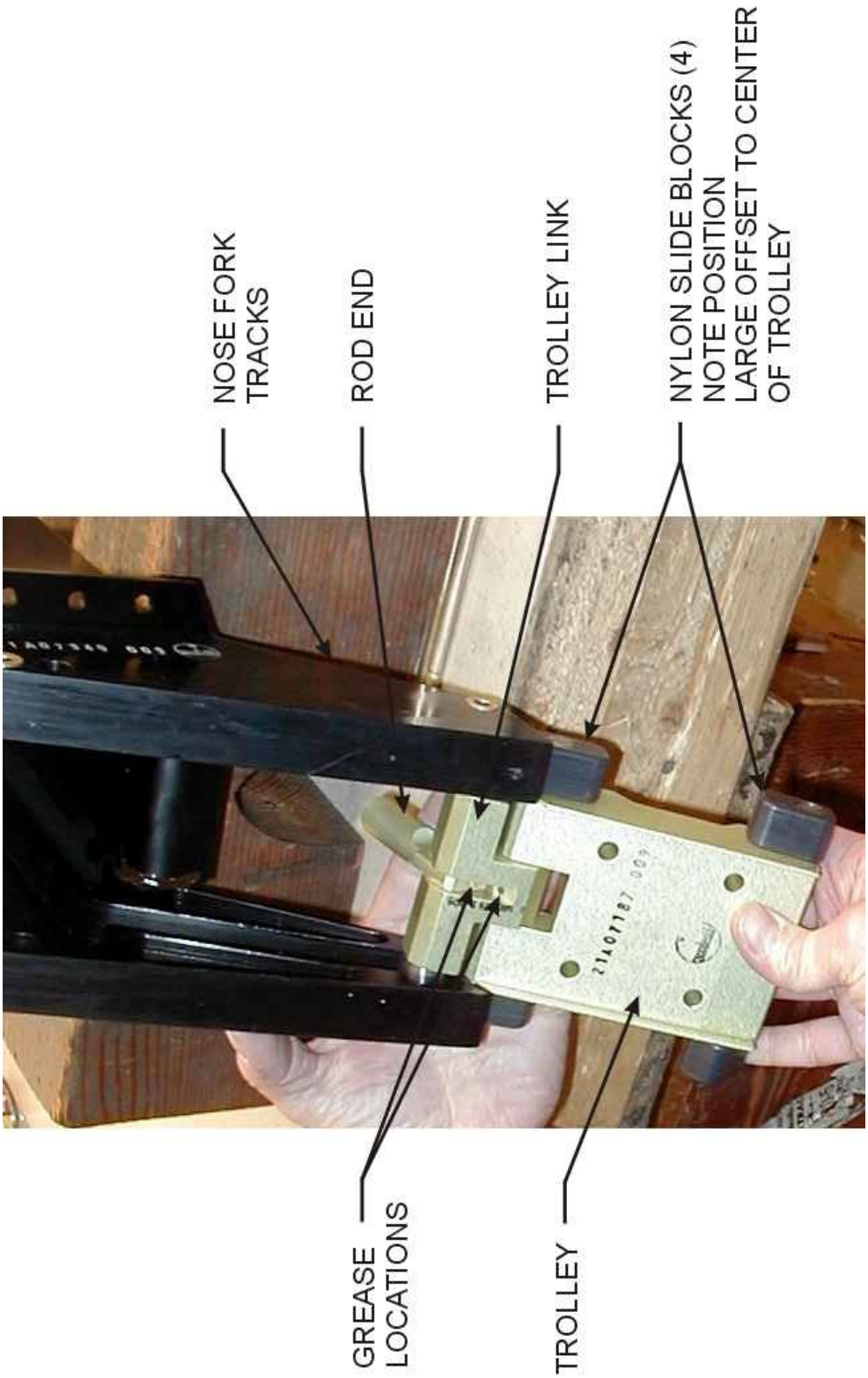


Figure 7-4. Position of Trolley to Nose Box

9. WATER RUDDER RETRACTION AND STEERING SYSTEM

9.1 Description

The water rudder retract system is manually operated by a lever through a system of cables and pulleys.

Steering is directed from the aircraft rudder steering system.

9.2 Adjustment

Rigging of the water rudder steering cables is accomplished by centering the airplane rudder and adjusting the turnbuckles such that both rudders trail with the float centerline. Cables should be tensioned to 10 pounds, +/- 5 psi.

Retraction cables should be rigged such that the rudder blade is in the up position and that the cables are just slack in the down position.

9.3 Service Schedule

Cables – inspect for fraying annually. Pulleys – inspect and lubricate annually.

INSPECTION TIME LIMITS			HOURS				Mech Initial		INSP.
			25	50	100	200	Rt	Lt	
General	Placards					X			
Hulls & Struts	Float Installation.	Float exterior – inspect for damage, wrinkled metal, corrosion, paint loss, etc.		X					
		Struts & attach fittings			X				
		Spreader bars			X				
		Float Structure (interior)				X			
	Baggage Compartment Covers and Seals – inspect for condition, security operation, excessive wear.	Remove inspection plates & baggage floor to inspect bulkhead flanges.			X				
	Pumper Tube Installation – inspect for condition, security, routing of hoses.					X			
Water Rudder System	Water Rudder Hinges – inspect freedom of rotation.		X						
	Water Rudder Steering and Retract Systems - inspect the following: cables for broken wire; cable fittings for cable slippage, cracks and distortion; cable pulleys for freedom of rotation; and cable guard pins for presence; rigging.	Inspect attach bolt steering cables at water rudder pivot.			X				
	Water Rudder Blades and Posts – inspect for damage, security of attachment, corrosion, paint, rigging.				X				
Electrical System	Pump and Indicator Light Wiring – inspect for chafing, broken or loose terminals and general condition.				X				
	Solenoids – inspect wiring, mounting and general condition.				X				
	Pressure Switches – Inspect wiring, mounting and general condition.				X				
	Pump Motors – inspect wiring, mounting and general condition.			X					

NOTES:

INSPECTION TIME LIMITS			HOURS				MECH. INITIAL		INSP.
			25	50	100	200	RT	LT	
Landing Gear Systems	Main and Nose Gear Tracks – lubricate.		X						
	Nose Gear Box/Block Tracks measured at slide route for wear, .020 inches or less wear tolerance.					X			
	Nose Gear Pivot Blocks and Forks – inspect for condition, lubrication, corrosion, paint.	Inspect Pivot Bolt	X						
	Nose and Main Wheel Bearing – grease Zerk fittings.		X						
	Hydraulic Fluid Level			X					
	Wheels and Tires – inspect for wear, pressure, condition.			X					
	Brake Assemblies – inspect for wear, corrosion, leakage.			X					
	Hydraulic Fluid Screen – clean and inspect. Note: If floats sit for extended periods of time (i.e., if removed during winter months), screen should be cleaned before putting floats back into service. Hydraulic fluid in reservoir should be checked for moisture or other contaminates and changed if necessary.				X				
	Main and Nose Gear Actuator, Assemblies – inspect for condition, lubrication, leakage, corrosion and cleanliness.				X				
	Nose Gear Springs – scotchply springs, inspect for cracks, delamination and paint.				X				
	Main Gear Drag Link – inspect for condition, lubrication, corrosion, check attach bolts for wear.				X				
	Main Gear Shock Strut – inspect for evidence of corrosion, pitting, cleanliness and security. Check lower attach bolt for water.			X					
	Hydraulic Lines and Fittings – inspect for leaks, condition and security.					X			
	Hydraulic Manifolds (if equipped) – inspect for condition, security and leaks.					X			
	Brake System Plumbing – inspect for leaks, condition and security.					X			

			25	50	100	200	Rt.	Lt.	INSP.
	Perform Retraction Test	Main Gear – inspect up and down for proper engagement.				X			
		Nose Gear Trolley – inspect for proper travel				X			
		Nose Gear – inspect for excessive side play in the down position.				X			
		Perform emergency gear extension (if equipped).				X			
	Nose and Main Wheel Bearings – disassemble and inspect.					X			
	Inspect and measure wear on Nose Gear Track Box					X			

TROUBLE SHOOTING

1. PROBLEM – Power pack does not run after gear selection.

PROBABLE CAUSE

a. Circuit breaker has failed.
b. Pressure switch not pulling in at low cut in.
c. Solenoid switch not pulling in.
d. Faulty pump motor.
e. Motor not properly grounded.

VERIFICATION AND REMEDY

a. Reset circuit breaker.
b. Short across pressure switch leads and see if motor runs. If motor operates, replace pressure switch.
c. Short across solenoid pressure switch leads and see if motor runs. If motor operates, replace solenoid pressure switch.
d. If c. above does not produce results and it is verified that voltage was actually applied to motor, it can be assumed motor is bad or not properly grounded.
e. Check motor ground.

2. PROBLEM – Powerpack does not shut off after gear reaches position.

PROBABLE CAUSE

a. Faulty pressure switch.
b. Faulty or dirty pressure relief valve allowing insufficient pressure buildup.

REMEDY

a. Replace pressure switch.
b. Clean and check relief valve.

3. PROBLEM – Power pack shuts off before gear reaches position.

PROBABLE CAUSE

a. Binding or jammed gear retractor, which causes pressure to build up (and stay up), and pressure switch shuts off power pack.

REMEDY

a. Repair retractor.

4. PROBLEM – Power pack cycles on and off after gear is in position.

PROBABLE CAUSE

a. Internal hydraulic leak.
b. External hydraulic leak.

REMEDY

a. Verify leak is not external by checking fluid level in reservoir and looking at couplings for oil leaks. If no external leaks are found, disconnect and cap off the hydraulic actuators one at a time and find the leaky one by process of elimination. If isolating entire system still indicates internal leak, powerpack check valve (located in pressure port of pump) is bad and needs replacement or reseating.
b. Visually inspect lines, cylinders, and hoses and replace as necessary.

5. PROBLEM – Power pack cycles on and off during gear cycle.

PROBABLE CAUSE

a. Binding in retraction unit.
b. Pressure switch cut off limit too low.

REMEDY

a. Investigate for free operation. Check gear that retracts last.
b. Replace pressure switch.

6. PROBLEM – Slow gear operation cycle (considerably longer than 30 seconds).

PROBABLE CAUSE

a. Plugged oil screen.
b. Poor electrical connection to motor. Check ground.
c. Poor motor.
d. Worn pump gears.

REMEDY

a. Clean intake screen located inside reservoir tank.
b. Connect motor direct to 12/24 volt source and note operation poor, motor needs overhaul.
c. Covered in (b) above.
d. Replace pump

7. PROBLEM – Circuit breaker pops during cycle.

PROBABLE CAUSE

a. Wire connections bad or corroded.
b. Bad motor brushes.

c. Bad circuit breaker.

REMEDY

a. Clean and protect terminal with grease.
b. Overhaul motor.
c. Replace circuit breaker.

8. <u>PROBLEM</u> – Power pack does not cycle up or down.

PROBABLE CAUSE

a. Pressure build-up in both sides of up and down lines.

REMEDY

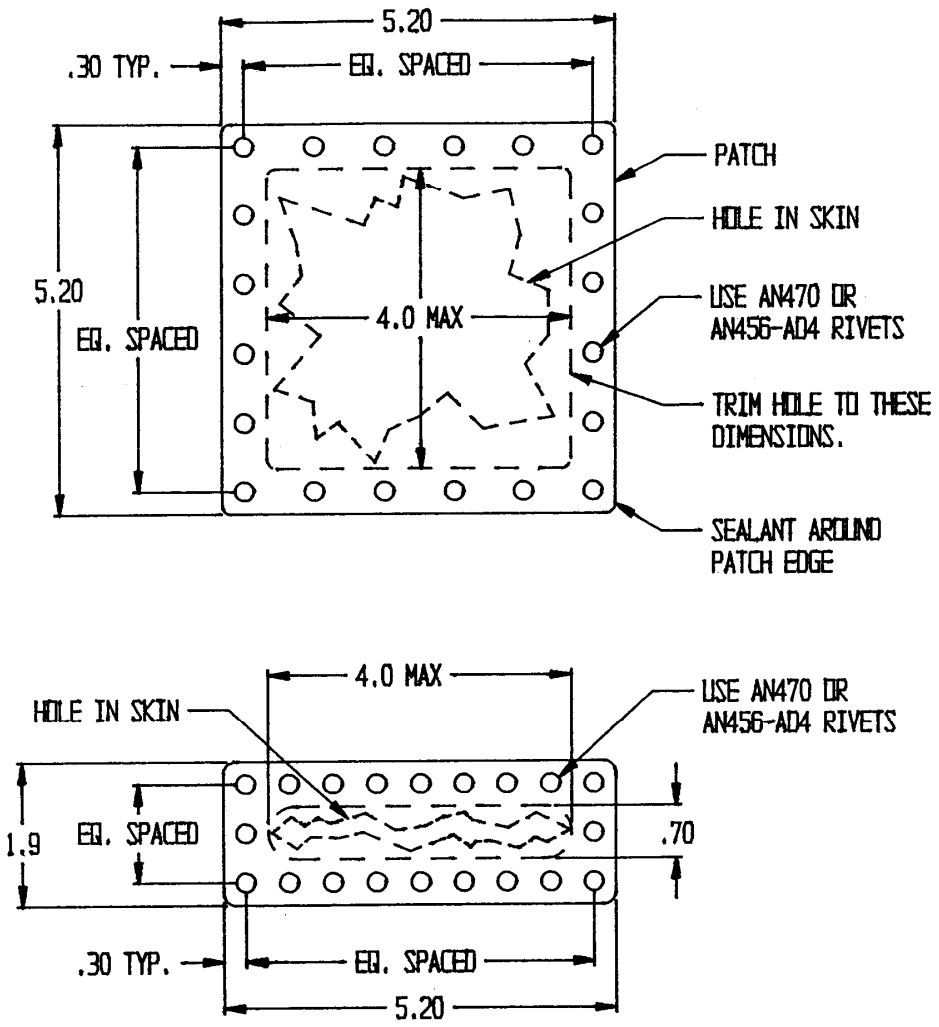
a. Select hand pump to up and down position to relieve pressure. Return to center and select gear.

<u>10</u> REPAIRING FLOAT HULL SKINS

The float hull is manufactured from the following aluminum alloys:
- Top skins –.025” thick, 6061-T6
- Side skins –.025 6061-T6
- Bottom skin – .032” thick, 2024-T3
- Nose bulkhead –.063” thick, 6061-T6
- All remaining forward bulkheads are .032” thick, 6061-T6
- Afterbody skin is .025” thick, 2024-T3
- All afterbody bulkheads are .032” thick, 6061-T6.

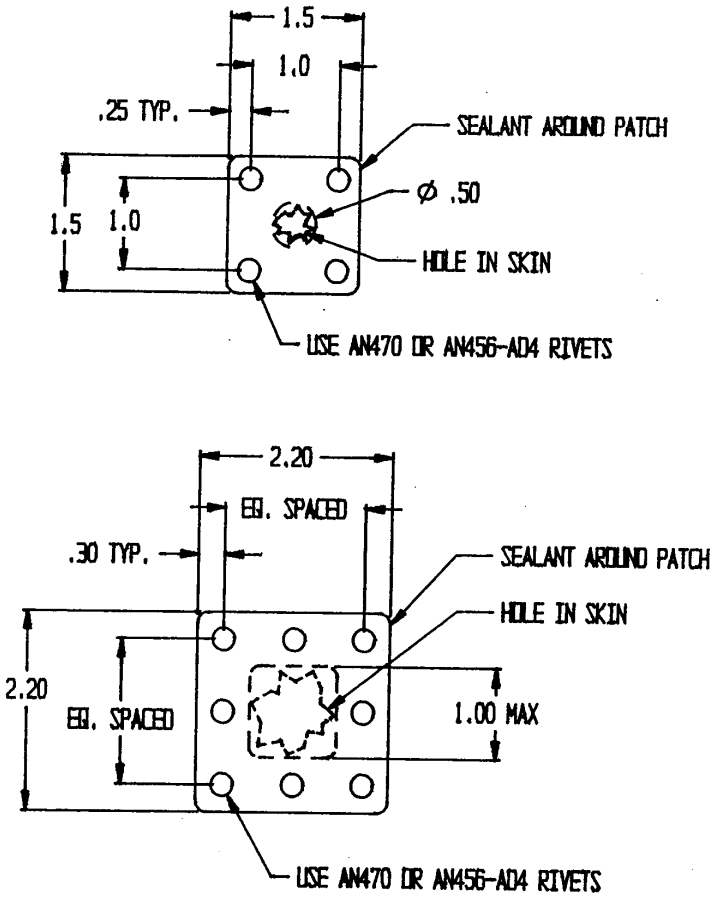
Damage to the skins may be repaired per Figures 9-1, 9-2, 9-3, or any acceptable repair method listed in FAA Advisory Circular 43.13.1A.

Any float hull skin or part thereof can be purchased from Wipaire to aid in repair. To simplify repairs, the skins are precut and drilled.



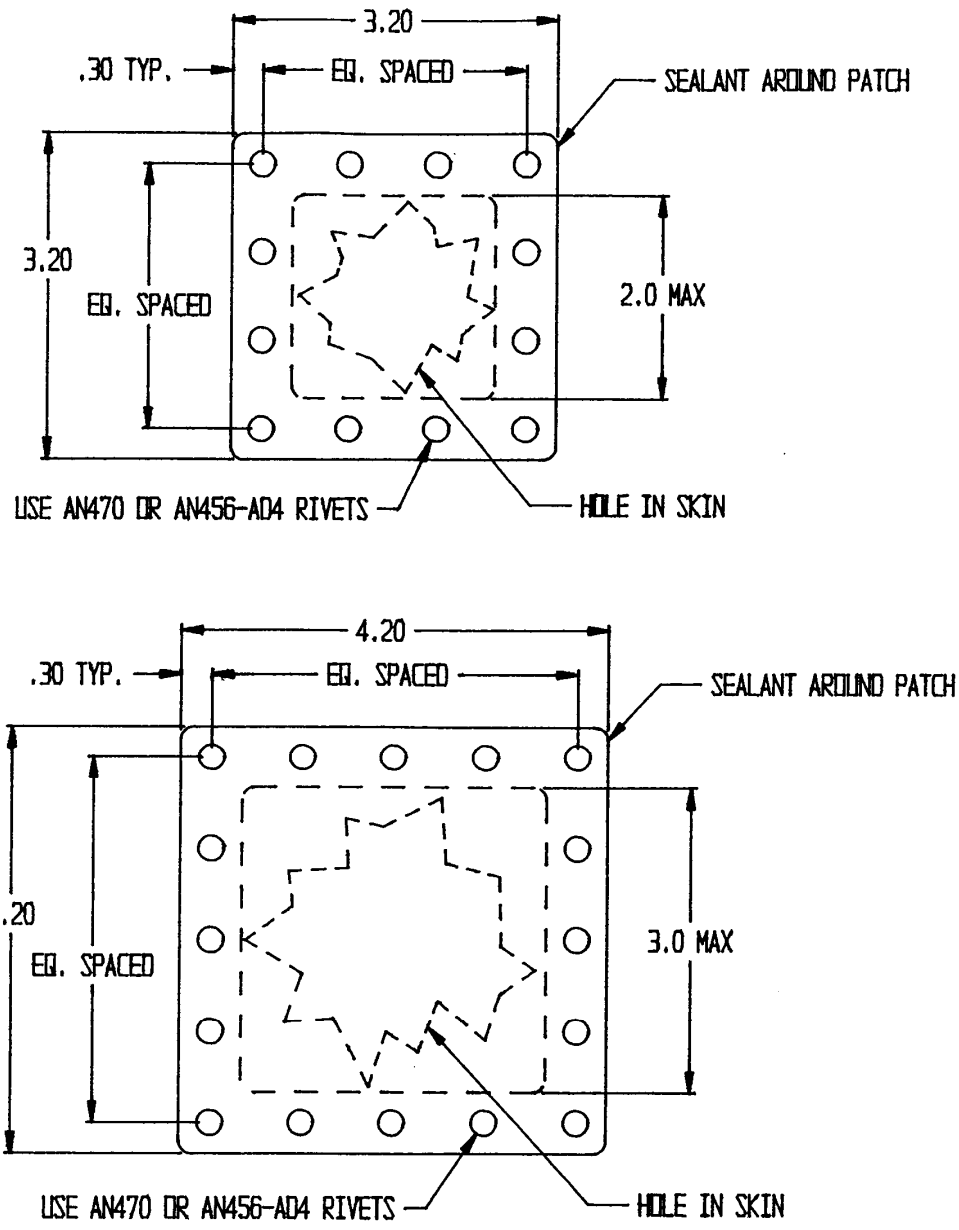
1. Trim hole as shown by dotted line.
2. Patch material to at least same thickness as original skin.
3. Prime all bare surfaces.
4. Seal between patch and skin.
5. Rivet in place.

Figure 9-1. Typical Skin Repair



1. Trim hole as shown by dotted line.
2. Patch material to at least same thickness as original skin.
3. Prime all bare surfaces.
4. Seal between patch and skin.
5. Rivet in place.

Figure 9-2. Typical Skin Repair



1. Trim hole as shown by dotted line.
2. Patch material to at least same thickness as original skin.
3. Prime all bare surfaces.
4. Seal between patch and skin.
5. Rivet in place.

Figure 9-3. Typical Skin Repair

KEEL SPLICE REPAIR

1. Remove rivets about 6-8” on either end of the area to be repaired.
2. Mark damaged area to be removed.

Note:
Be sure to start and end spliced area in the centers of the floats bays to prevent interference with the bulkheads or bottom stiffeners.

3. Use a cutting wheel to carefully cut out the damage part of the keel.

Warning!!
Be sure not to cut into the skins!!

4. Obtain entire new keel from Wipline Parts Dept. (Amphib. p/n 23A01321-002 or Seaplane p/n 23S01321-003) and match the contour area. Cut out the necessary area from the new keel in the exact area of the damage. Holes are already drilled into the keels from the factory. Match the holes from the original keels; they should fit exactly.

5. Cut out repair section to match needed repair area. Cutting the splice ends as shown in figure 1 is recommended but not required.

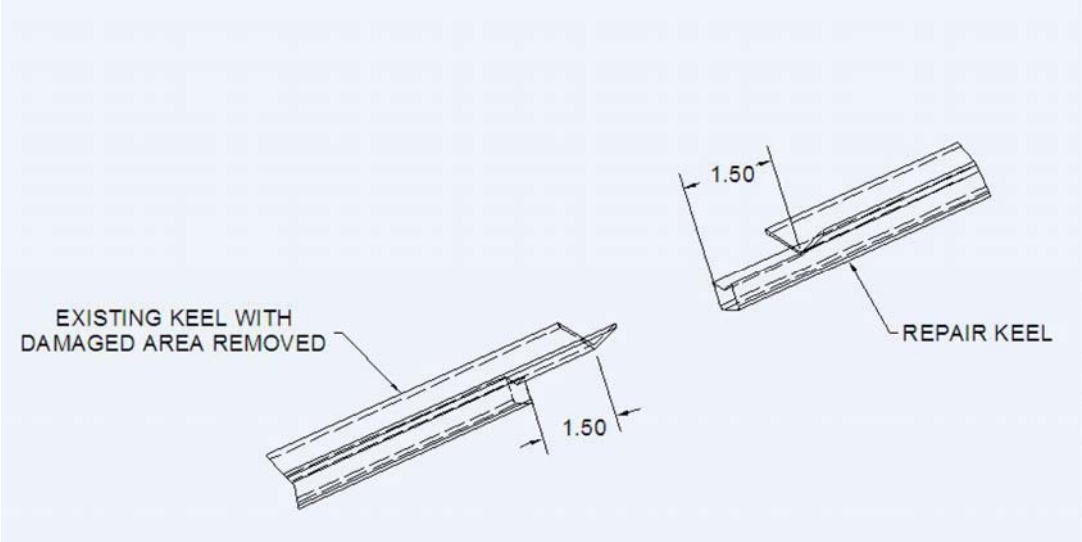


Figure 9.4 Splice Section Cuts

6. Trim repair section to fit in damaged area exactly and file to remove rough edges.

7. Fabricate keel splice doubler sections from 6061-T6 .060” aluminum and using figure 9.5 as recommended dimensions.

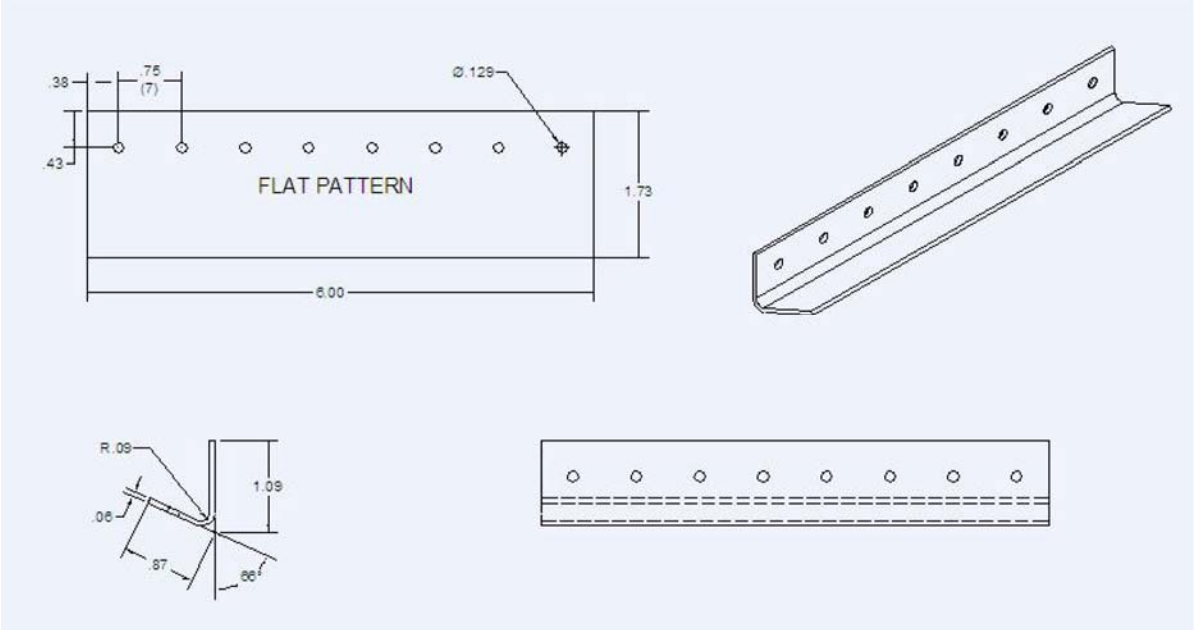


Figure 9.5 Doubler Sections

8. Back drill the splice parts from existing holes. Be sure to center the splice on the split of the repair area.
9. Clean and deburr all holes.

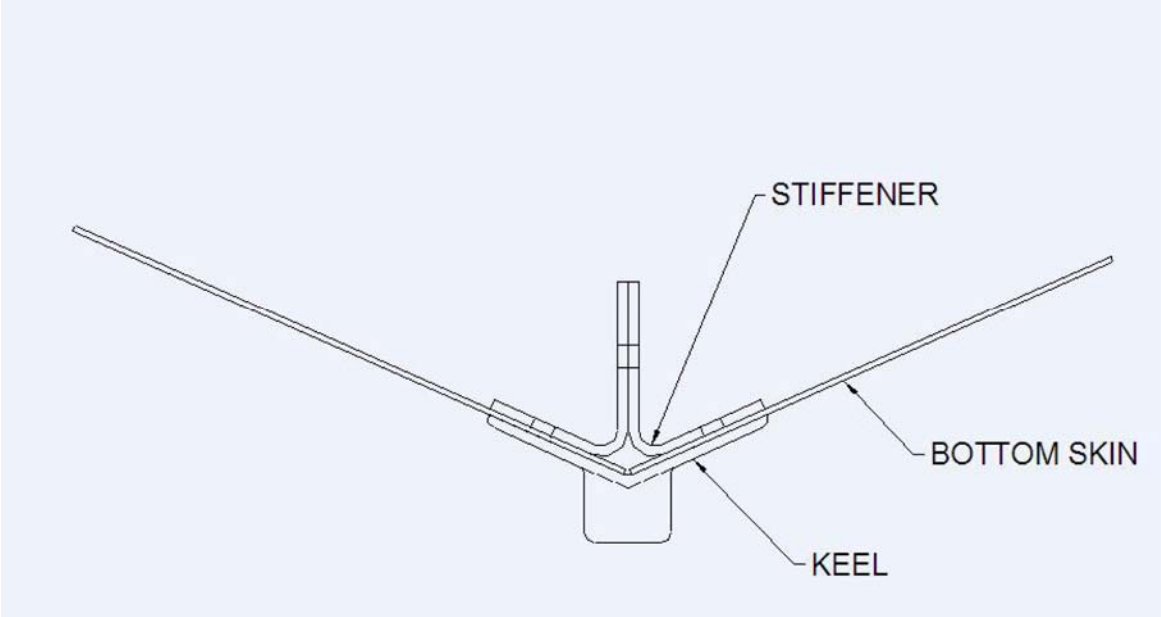


Figure 9.6 Front View with Stiffeners

10. Wet the skin under the repair with the required sealant. Sika Flex polyurethane sealant or PRC sealant (PR890 or PR1422).
11. Rivet together with appropriate diameter and length rivets depending on splice location with structural rivets. Clean excess sealant from the repair areas with MEK or equivalent solvent.
12. Shave or file the repair seam areas if needed for flush fit to existing keel.
13. Test the compartments after the sealant dries (usually overnight) for leaks with plain water.
14. Treat repaired area with Alodine for corrosion protection. Then prime and paint to match existing paint as desired.

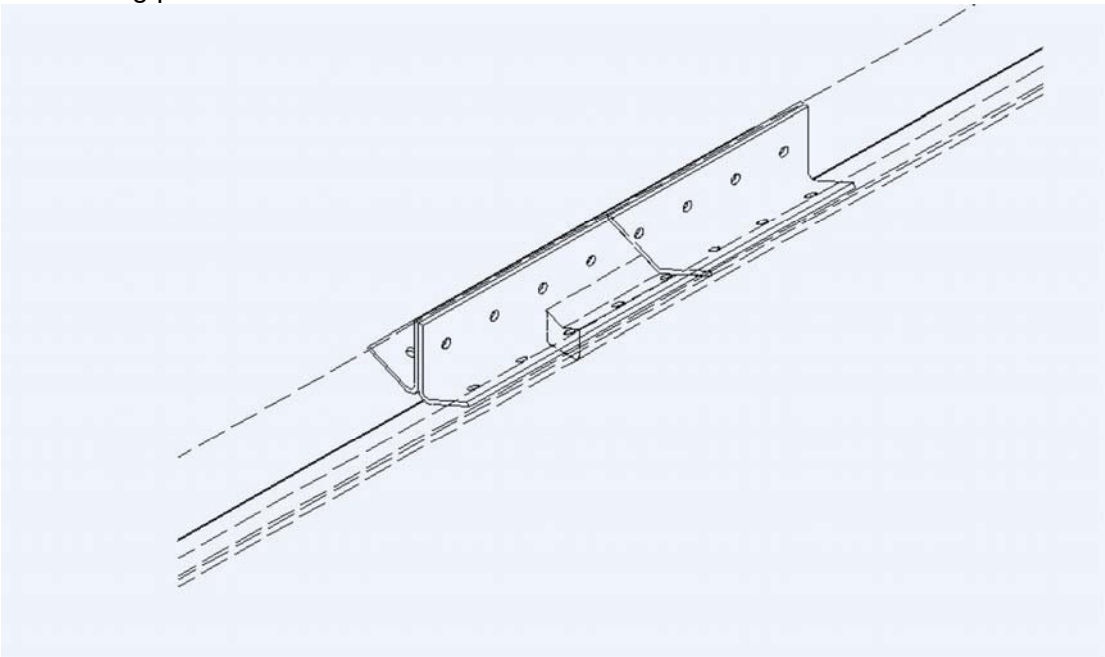


Figure 9.7 Finished Keel with Stiffeners

Weighing procedures for the Piper PA-18 Floatplane

Level aircraft per manufacturer's instructions.

Place scales under the right and left nose and main gear wheels.
Place blocking under the right and left main gears to level aircraft.

Drop plumb bob from the wing leading edge to the floor and mark a line to establish station 0.0, the datum.

Measure the distance from 0.0 to each nose wheel center. This is X1 and X2.
Measure the distance from 0.0 to each main wheel center. This is Y1 and Y2.

Use this table for the calculations:

	Scale Reading **Weight**	**x**	Distance from 0.0 **Arm**	**=**	Weight x Arm **Moment**
Left Front	+		- X1		-
Right Front	+		- X2		-
Left Rear	+		+ Y1		+
Right Rear	+		+ Y2		+
Totals					

Notes:

1. Zero out or deduct tare weights at the Y arms.
2. If using an overhead hoist and load cell, pick up aircraft at the center line of the front spar wing butt fittings. The center line of the front spar is +9 inches from the datum.
3. Level the aircraft by placing weight on the float deck where it is needed. Record the tare weight and arm.

Weighing procedures for the Piper PA-12 Floatplane

Level aircraft per manufacturer's instructions or drop a plumb bob from the machine screw at the door frame channels at rear upper corner of the door to a hole in the plate near the rear seat. When these meet the plane is level.

Place scales under the right and left nose and main gear wheels. Place blocking under the right and left main gears to level aircraft.

Drop plumb bob from the wing leading edge to floor and mark with a line. This line is the datum, 0.0 in the calculations.

Measure the distance from 0.0 to each nose wheel center. This is X1 and X2.
Measure the distance from 0.0 to each main wheel center. This is Y1 and Y2.

If the floats are seaplane floats, the scales go under the step point in the rear and a point towards the front of the float. These distances are measured and become the same X and Y as for the amphibian.

Use this table for the calculations:

	Scale Reading **Weight**	x	Distance from 0.0 **Arm**	=	Weight x Arm **Moment**
Left Front	+		- X1		-
Right Front	+		- X2		-
Left Rear	+		+ Y1		+
Right Rear	+		+ Y2		+
Totals					

Notes:

1. Zero out or deduct tare weights at the Y arms.
2. If using an overhead hoist and load cell, pick up aircraft at the center line of the front spar wing butt fittings. The center line of the front spar is +9 inches from the datum.
3. Level the aircraft by placing weight on the float deck where it is needed. Record the tare weight and arm.

Weighing procedure for the Cub Crafter PA-18 Floatplane

Level aircraft per manufacturer's instructions in Maintenance Manual TC10000AMM.

Place scales under the right and left main and nose gears.
Place blocking under the right and left main gears to level aircraft.

Drop plumb bob from the wing leading edge and mark the floor parallel to the aircraft leading edge. Measure 60.0 inches forward of the leading edge line and mark a line. This 2nd line is the datum, 0.0.

Measure the distance from 0.0 to each nose wheel center. This is X1 and X2.
Measure the distance from 0.0 to each main wheel center. This is Y1 and Y2.

Use this table for the calculations:

	Scale Reading **Weight**	**x**	Distance from 0.0 **Arm**	**=**	Weight x Arm **Moment**
Left Front	+		- X1		-
Right Front	+		- X2		-
Left Rear	+		+ Y1		+
Right Rear	+		+ Y2		+
Totals					

Notes:

1. Zero out or deduct tare weights at the Y arms.
2. If using an overhead hoist and load cell, pick up aircraft at the center line of the front spar wing butt fittings. The center line of the front spar is +9 inches from the datum.
3. Level the aircraft by placing weight on the float deck where it is needed. Record the tare weight and arm.

Weighing procedure for the Husky A-1, A-1A or A-1B Floatplane

Level aircraft per manufacturer's instructions or use the cabin door lower sill.

Place scales under the right and left main and nose gears.
Place blocking under the right and left main gears to level aircraft.

Drop plumb bob from the wing leading edge and mark the floor parallel to the aircraft leading edge. Measure 60.0 inches forward of the leading edge line and mark a line. This line is the datum, 0.0.

Measure the distance from 0.0 to each nose wheel center. This is X1 and X2.
Measure the distance from 0.0 to each main wheel center. This is Y1 and Y2.

Use this table for the calculations:

	Scale Reading **Weight**	**x**	Distance from 0.0 **Arm**	**=**	Weight x Arm **Moment**
Left Front	+	-	X1		-
Right Front	+	-	X2		-
Left Rear	+	+	Y1		+
Right Rear	+	+	Y2		+

Totals

Notes:

1. Zero out or deduct tare weights at the Y arms.
2. If using an overhead hoist and load cell, pick up aircraft at the center line of the front spar wing butt fittings. The center line of the front spar is +9 inches from the datum.
3. Level the aircraft by placing weight on the float deck where it is needed. Record the tare weight and arm.

Weighing Procedure for Cessna 172 Floatplane

Level the aircraft as per the weight and balance section of the landplane handbook.

Place the scales under all 4 wheels. Place whatever blocking is required under the mail gears to level the aircraft.

Drop a plumb bob from the face of the firewall and mark the floor. This mark is 0.0 in the calculations.

Measure the distance from 0.0 to each nose wheel center. This is X_1 and X_2.
Measure the distance from 0.0 to each main wheel center. This is Y_1 and Y_2.

If the floats are seaplane floats, the scales go under the step point in the rear and a point towards the front of the float. These distances are measured and become the same X and Y as for the amphibian.

Use this table for the calculations:

	Scale Reading **Weight**	**x**	Distance from 0.0 **Arm**	**=**	Weight x Arm **Moment**
Left Front	+	-	X_1		-
Right Front	+	-	X_2		-
Left Rear	+	+	Y_1		+
Right Rear	+	+	Y_2		+

Totals

Notes:

1. Zero out or deduct tare weights at the Y arms.
2. If using overhead hoist and weight load cell, pick up aircraft at the front spar lifting rings. Arm of lifting rings at the aircraft station +33.58. Level the aircraft by placing weight on the float deck to balance. Record tare weight and arm.

Weighing Procedure for Cessna 170 Floatplane

Level the aircraft as per the weight and balance section of the landplane handbook or use the upper pilot's door sill.

Place the scales under all 4 wheels. Place whatever blocking is required under the mail gears to level the aircraft.

Drop a plumb bob from the face of the firewall and mark the floor with a line. This line is 0.0 in the calculations.

Measure the distance from 0.0 to each nose wheel center. This is X_1 and X_2.
Measure the distance from 0.0 to each main wheel center. This is Y_1 and Y_2.

If the floats are seaplane floats, the scales go under the step point in the rear and a point towards the front of the float. These distances are measured and become the same X and Y as for the amphibian.

Use this table for the calculations:

	Scale Reading **Weight**		Distance from 0.0 **Arm**		Weight x Arm **Moment**
Left Front	+	-	X_1		-
Right Front	+	-	X_2		-
Left Rear	+	+	Y_1		+
Right Rear	+	+	Y_2		+

Totals

Notes:

1. Zero out or deduct tare weights at the Y arms.
2. If using overhead hoist and weight load cell, pick up aircraft at the front spar lifting rings. Arm of lifting rings at the aircraft station +33.58. Level the aircraft by placing weight on the float deck to balance. Record tare weight and arm.

Weighing Procedure for Cessna 175 Floatplane

Level the aircraft as per the weight and balance section of the landplane handbook or use the upper pilot's door sill.

Place the scales under all 4 wheels. Place whatever blocking is required under the mail gears to level the aircraft.

Drop a plumb bob from the face of the firewall and mark the floor with a line. This line is 0.0 in the calculations.

Measure the distance from 0.0 to each nose wheel center. This is X_1 and X_2.
Measure the distance from 0.0 to each main wheel center. This is Y_1 and Y_2.

If the floats are seaplane floats, the scales go under the step point in the rear and a point towards the front of the float. These distances are measured and become the same X and Y as for the amphibian.

Use this table for the calculations:

	Scale Reading **Weight**	x	Distance from 0.0 **Arm**	=	Weight x Arm **Moment**
Left Front	+	-	X_1		-
Right Front	+	-	X_2		-
Left Rear	+	+	Y_1		+
Right Rear	+	+	Y_2		+

Totals

Notes:

1. Zero out or deduct tare weights at the Y arms.
2. If using overhead hoist and weight load cell, pick up aircraft at the front spar lifting rings. Arm of lifting rings at the aircraft station +33.58. Level the aircraft by placing weight on the float deck to balance. Record tare weight and arm.

Weighing Procedure for 8GCBC Scout Floatplane

Level the aircraft as per the weight and balance section of the landplane handbook or draw a pencil mark on the top of the stub gear, 10 3/16" from the front face of the front lift strut attach lug. Drop a plumb bob from the wing leading edge and lift the tail until the plumb reaches this mark. Plane is now level.

Place the scales under all 4 wheels. Place whatever blocking is required under the main gears to level the aircraft.

Drop the plumb bob from the leading edge to the floor and mark with a line. This line is the datum, 0.0.

Measure the distance from 0.0 to each nose wheel center. This is X_1 and X_2.
Measure the distance from 0.0 to each main wheel center. This is Y_1 and Y_2.

If the floats are seaplane floats, the scales go under the step point in the rear and a point towards the front of the float. These distances are measured and become the same X and Y as for the amphibian.

Use this table for the calculations:

	Scale Reading **Weight**		Distance from 0.0 **Arm**		Weight x Arm **Moment**
Left Front	+	-	X_1	=	-
Right Front	+	-	X_2	=	-
Left Rear	+	+	Y_1	=	+
Right Rear	+	+	Y_2	=	+

Totals

Notes:

1. Zero out or deduct tare weights at the Y arms.
2. If using overhead hoist and weight load cell, pick up aircraft at centerline of front spar wing butt fittings. The centerline of the front spar is +9.0" from the datum. Level the aircraft by placing weight on the float deck to balance. Record tare weight and arm.

TX 760 D
VHF COMM TRANSCEIVER

MAINTENANCE MANUAL

TERRA
BY TRIMBLE

Trimble
2105 Donley Dr.
Austin, Texas 78758
Phone (512) 432-0400
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TERRA TX 760D

VHF COMMUNICATIONS TRANSCEIVER

MAINTENANCE MANUAL

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Part Number 1920-0011-01
Revision R

TX 760D VHF COMMUNICATIONS TRANSCEIVER
MAINTENANCE MANUAL

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SECTION 1

1. INTRODUCTION

1.1 SCOPE

This manual provides specifications, theory of operations and alignment procedures along with installation and operating instructions for the TERRA TX 760D VHF Communications Transceiver manufactured by TERRA Corporation, Albuquerque, New Mexico.

1.2 DESCRIPTION

The TERRA TX 760D is a small, lightweight, all solid-state, amplitude modulated, 5 watt VHF transceiver. The TX 760D provides simplex communication on any one of 760 channels with 25 KHZ spacing. Featuring a planar gas discharge digital display, the TX 760D provides active and standby frequency indication, memory, and knob operated frequency selection.

The TX 760D features a digital frequency synthesizer that employs one crystal for generating the frequencies required for transmit and receive functions on all 760 channels. Other features include automatic voice leveling on transmit and receive, crystal monolithic I.F. filters, integrated circuit I.F. amplifiers, and internal two place VOX intercom capability. Use of a low noise MOSFET RF amplifier, automatic squelch circuit with manual override, solid-state antenna switching, switching power supply with overload protection, and microprocessor controlled frequency selection and monitoring make the TX 760D a reliable answer to today's communication requirements.

The transceiver can be mounted in three different configurations: in a single tray, in a dual tray, or in a 3" ATI hole using the 3" adapter. When using the tray mounted units all power and control connections are made through a 15 pin "D" type connector installed on the rear of the mounting tray. A BNC female chassis connector is used for antenna connections. If the 3" option is selected a locking, hooded, 15 pin "D" type connector and standard BNC connector are used for power, control and antenna interfacing. The TX 760D, when tray mounted, is secured by means of a positive locking cam, accessible through the front panel, using a 7/64" Allen wrench. The 3" option is mounted with minimum of 3 screws through the instrument panel.

Weighing only 1.50 lb. (0.680 kg), the TX 760D measures 11.45" long, 3.125" wide, and 1.625" high (29.08 cm x 7.9375 cm x 4.1275 cm). Panel cutout is a 3.03" x 1.54" (7.6962 cm x 3.9116 cm) and overall length of the unit is 13.05" (33.147 cm) including mounting tray.

Requiring only 325 ma. of standby current and 2.5 amps during transmit, the TX 760D operates cooler than one would imagine at 13.75 VDC. Operation at 27.5 VDC is possible by utilization of an optional TERRA MLC 28-5 power converter. The TX 760D is designed to operate with standard aircraft microphones, headsets, speakers, auxiliary audio inputs and 50 Ω broad-band communication antenna systems.

1.3 SPECIFICATIONS

The following are pertinent specifications for the FCC type-accepted TERRA Model TX 760D transceiver.

1.3.1 MECHANICAL SPECIFICATIONS

Mounting:	Panel mounted using mounting tray supplied with unit or 3" adapter as provided
Overall Dimensions:	13.05" long, 3.125" wide, 1.625" high (33.14 cm long, 7.9375 cm wide, 4.1275 cm high)
Mounting Dimensions:	11.45" behind panel, 3.125" wide, 1.625" high (29.08 cm behind panel, 7.9375 cm wide, 4.1275 cm high)
Panel Cutout:	3.03" x 1.54" (7.692 cm x 3.9116 cm)
Weight:	1.50 pounds (0.680 kg)
Connectors:	Antenna input/output; BNC Interconnect; 15 pin "D" type

1.3.2 POWER REQUIREMENTS

The TERRA TX 760D transceiver requires 13.75 VDC +10%, -20% input at 2.5 amps maximum load condition.

1.3.3 ENVIRONMENTAL SPECIFICATIONS

Maximum Operating Conditions

Altitude:	To 30,000 feet (9,150 meters)
Humidity:	To 95% at 50°C (122°F)
Temperature Range:	-20°C (-4°F) to +55°C (+131°F)
Vibration:	0.5 G from 5 to 500 Hz

1.3.4 ELECTRICAL SPECIFICATIONS

(All specifications at 13.75 VDC nominal)

RECEIVER

Frequency Range:	118.00 to 136.975 MHZ
Number of Channels:	760
Channel Spacing:	25 Khz
Sensitivity:	Less than 2 µV for 6dBm signal plus noise to noise ratio.
Selectivity:	Typically -6dBm at 14 KHz and -60dBm at 40 KHz.
Squelch Sensitivity:	Automatic: 2 to 5 µV Manual: 25 to 150 µV
Automatic Gain Control (AGC):	Audio flat within 3dB for 3 µV to 30,000 µV input.
Undesired Response:	Greater than 60dBm down.
Adjacent Channel	

I.3 SPECIFICATIONS (Continued)

Rejection:	Greater than 60dBm.
Auxiliary Inputs:	3 inputs with minimum of 30dBm isolation. One volt input at 1 KHz will produce one volt output across a 3.2 Ω resistor connected to the speaker terminals.
Incidental Radiation:	Certified per FCC Part 15 requirements.
TRANSMITTER	
Frequency Range:	118.00 to 136.975 MHZ
Number of Channels:	760
Frequency Stability:	±0.002% per FCC Type Acceptance.
Power Output:	5 watts nominal, unmodulated carrier; 20 watts PEP.
Modulation:	Automatic audio leveling for a minimum of 80% and a maximum of 95%.
Emission Type:	6K00A3E
Output Termination:	50 Ω nominal.
Spurious Responses:	Greater than 50dBm below carrier level.
Sidetone:	Up to 25 milliwatts into 600 Ω headphones.
FCC Approval:	Type accepted per FCC Part 87.

1.4 EQUIPMENT SUPPLIED

The equipment supplied will depend upon the "system" you have ordered. The part numbers and descriptions listed below indicate the equipment supplied with the TX 760D only. If a system other than those listed below was ordered, additional equipment will have been supplied and listed in another manual.

0990-5302-00 TX 760D, Single System

1.	1ea.	Comm Transceiver, TERRA TX 760D P/N 0900-0405-00
2.	1ea.	Mounting Tray, Single P/N 1900-0357-10
3.	1ea.	Installation Kit P/N 1901-2671-10
4.	1ea.	Operation/Installation Manual TX 760D P/N 1910-0008-01
5.	1ea.	Warranty Card
6.	1ea.	FCC Form 404
7.	1ea.	FCC Form 406

0990-5318-00 TX 760D, 3" System

1.	1ea.	Comm Transceiver, TERRA TX 760D P/N 0900-0405-00
2.	1ea.	Mod Kit, TX 760D P/N 1901-5312-40

1.4 EQUIPMENT SUPPLIED (Continued)

3.	1ea.	Operation/Installation Manual TX 760D P/N 1910-0008-01
4.	1ea	Warranty Card
5.	1ea	FCC Form 404
6.	1ea	FCC Form 406

1.4.1 OPTIONAL EQUIPMENT

Noise-canceling Microphone, Carbon, Push-to-talk TERRA P/N 0900-0151-01

Voltage Converter 27.50 to 13.75 V
Model MLC 28-5 TERRA P/N 0900-3219-12

Push-to-talk Switch
TERRA P/N 0900-0203-01

Headset with Microphone
TERRA P/N 0900-0201-11

Ext. VOX Kit, Pot. and Knobs
TERRA P/N 1901-5322-00

1.5 ADDITIONAL EQUIPMENT REQUIRED

1. Sufficient RG 58A/U 50 Ω co-axial antenna cable to reach from the transceiver to the antenna. BNC co-axial fittings as required for the particular installation. If cable length exceeds 20 feet RG8 co-axial cable is recommended
2. MIL 22759 or equivalent wire sufficient to make the harness.
3. Microphone and headphone jacks as required.
4. Circuit breaker rated at 4 amps.
5. 50 Ω communications antenna rated at top speed of the aircraft.

1.6 LICENSE REQUIREMENTS

The operator of the TERRA TX 760D transceiver is required by the Federal Communications Commission to hold a restricted radio-telephone operator's permit, or a higher class of license. A U.S. citizen may obtain the operator permit from the nearest FCC office.

The transceiver, when installed in an aircraft, requires an Aircraft Radio Station License. This license may be obtained by filing an FCC Form 404. The transceiver should be identified on the form as CCXTX760D under Type Acceptance Number. If a copy of the filed Form 404 is kept in the aircraft, the TX 760D may be operated up to 30 days while awaiting the formal license. For Ground Station operation, Form 406 should be filed as above.

SECTION IV

4. OPERATION

4.1 SCOPE

This section is to instruct the owner/operator in the proper "care and feeding" of their new TERRA TX 760D VHF communications transceiver.

4.2 OPERATION

See Drawing #9-1160-0010-01 for locations and descriptions of the TX 760D Front Panel Controls.

CAUTION!

Insure the TX 760D is turned off until after engine start-up procedures are completed. This simple precaution will greatly improve the lifetime of all of your avionics as well as your new TX 760D.

4.3 FREQUENCY MODE

To turn power on, rotate the small inner left knob clockwise. A slight detent will be felt. Left to right the following will be displayed in the window:

188.88 T/R 8 m 188.88

After 5 seconds the displays will revert back to the last used frequencies.

Enter your desired frequency in the right hand or "standby" window, by turning the tune knob on the right-hand side. The faster this knob is rotated the more the frequency changes with each detent. Clockwise tuning increases the frequency and counterclockwise tuning decreases the frequency. At the upper and lower limits of the frequency band i.e., 118.00 and 136.975, the frequency will "wrap around". This allows faster tuning from one end of the band to the other.

After the desired frequency is obtained, simply press the <--> (TRANSFER) button to move the new frequency into the left-hand or "active" window and your previously used frequency to the right-hand or "standby" window.

4.4 NORMAL OPERATION

Rotate the squelch (large left-hand outer) knob clockwise until background noise is heard. Rotate the volume (small left-hand inner knob) until this noise corresponds to a desired listening level.

Rotate the squelch knob counterclockwise until a detent is felt. This places the TX 760D in the "auto squelch" mode.

With the desired frequency entered in the left-hand (ACTIVE) window as described above, key your microphone and you will be transmitting on the active frequency. Releasing the key will automatically place your TX 760D in the receive mode.

4.5 FREQUENCY TRANSFER

As previously described in Section 4.3, simply pressing this button will "swap" frequencies between active and standby windows.

As will be covered in the next section, depressing this button also cancels the channel memory display.

The transfer button must be used in order for the last frequencies used to be displayed after a power interruption. For example, say you are tuned to 118.00 in the active display and 121.60 in the standby display. Pressing the transfer button will insure that the unit will display "121.60 118.00" after any power interruption. Failure to do this transfer will cause the unit to come up with 118.00 in the active display and the last transferred frequency in the standby display.

4.6 TO PLACE FREQUENCIES IN MEMORY

The TX 760D has a 10 channel memory, with 9 of these memories user programmable and 1 non-user programmable for the emergency frequency. To place frequencies in memory, push the tune knob in. In between the active and standby window, "O" will be displayed. Rotating the tune knob, while holding it in, will increment or decrement the channel number from 0 through 9 or vice-versa. After rotating the tune knob 1 detent from "O", an "M" will appear in the display beside the number (See Example).

After you obtain the desired channel number, simply release the knob and rotate the tune knob to your desired storage frequency. Press the "STO" (STORE) button and that frequency is now entered in the indicated channel memory.

EXAMPLE:
At your airport, the following frequencies are used:

ATIS:	118.00
Clearance Delivery:	119.30
Ground Control:	121.90
Tower:	118.30
Departure:	124.40
Company Frequency:	134.375

For simplicity, we will assign channel numbers in the same order. To enter the above frequencies in memory, follow these steps:

Push tune knob:	XXX.XX O XXX.XX
Hold in and rotate:	XXX.XX 1m XXX.XX
Release and tune:	XXX.XX 1 118.00
Press "STO":	XXX.XX 1m 118.00
Push tune knob and hold:	XXX.XX 1m 118.00
Rotate tune knob:	XXX.XX 2m XXX.XX
Release and tune:	XXX.XX 2 119.30
Press "STO":	XXX.XX 2m 119.30

Continue until all frequencies, that are desired, are "loaded in". Then you are ready to recall them at any time.

4.7 MEMORY/CHANNEL MODE

Turn the unit off and then on again after completing the above step. After power on, push tune knob and rotate to "1m". Press transfer button and 118.00 moves to the active window. The previously displayed active frequency moves to the standby window, and "1m" is cleared from the display. To gain access to any channel, simply push the tune button in, rotate to desired channel, press the transfer button, and you are on your desired channel.

4.8 VOX INTERCOM OPERATION

The VOX Intercom option allows hands free communication between pilot and co-pilot. The following suggestions and comments will allow proper use and function of the VOX Intercom circuitry;

a) Both pilot and co-pilot microphone's should be of the same type. (i.e., 2 dynamic or 2 noise canceling, not 1 of each.)
b) Speak loudly and clearly.
c) Speak with the microphone on the lips.
d) Use a foam covering on microphone to eliminate any sound of breathing or wind noise.

The VOX Intercom squelch level is preset at the factory, but any TX 760D with Mod 5 installed has the option of a user adjustable, external VOX Intercom squelch control. This allows a user to set the VOX Intercom squelch for different conditions in the cockpit, (i.e., full throttle and cruise). Also all TX 760D's with Mod level 8 and above, have the option of both the squelch and a user adjustable, external VOX Intercom volume control. This allows the user to set both the volume and squelch levels for different conditions in the cockpit. See Section 2.3 #12 for more information on these features.

4.9 EMERGENCY OPERATION

Memory location #9 has been "partitioned off" and the frequency 121.50 has been programmed into that memory. Your TX 760D will not allow you to program any frequency into this location. In the event of a situation that requires communication on the emergency frequency, simply press the tune knob and turn until "9m" appears along with 121.50 in the standby window and then press the transfer <--> key.

4.10 BLIND OPERATION

In the unlikely event of a display failure, power the unit down for a few seconds. Upon power up wait 5 seconds for the unit to initialize. Then simply press in the tuning knob and rotate 1 detent counterclockwise. This will recall 121.50 into the "standby" window, and a push of the transfer <--> button will then channel the radio to 121.50. If a record has been made of the frequencies that you have stored within the memories, the same method as above will work with any memory location. Remember that any time you power the unit down and then power back up, when you press in the tuning knob you are at memory location 0. Then rotate one detent clockwise for memory location 1, two detents clockwise for memory location 2, etc.

4.11 FAILURE MODE OPERATION

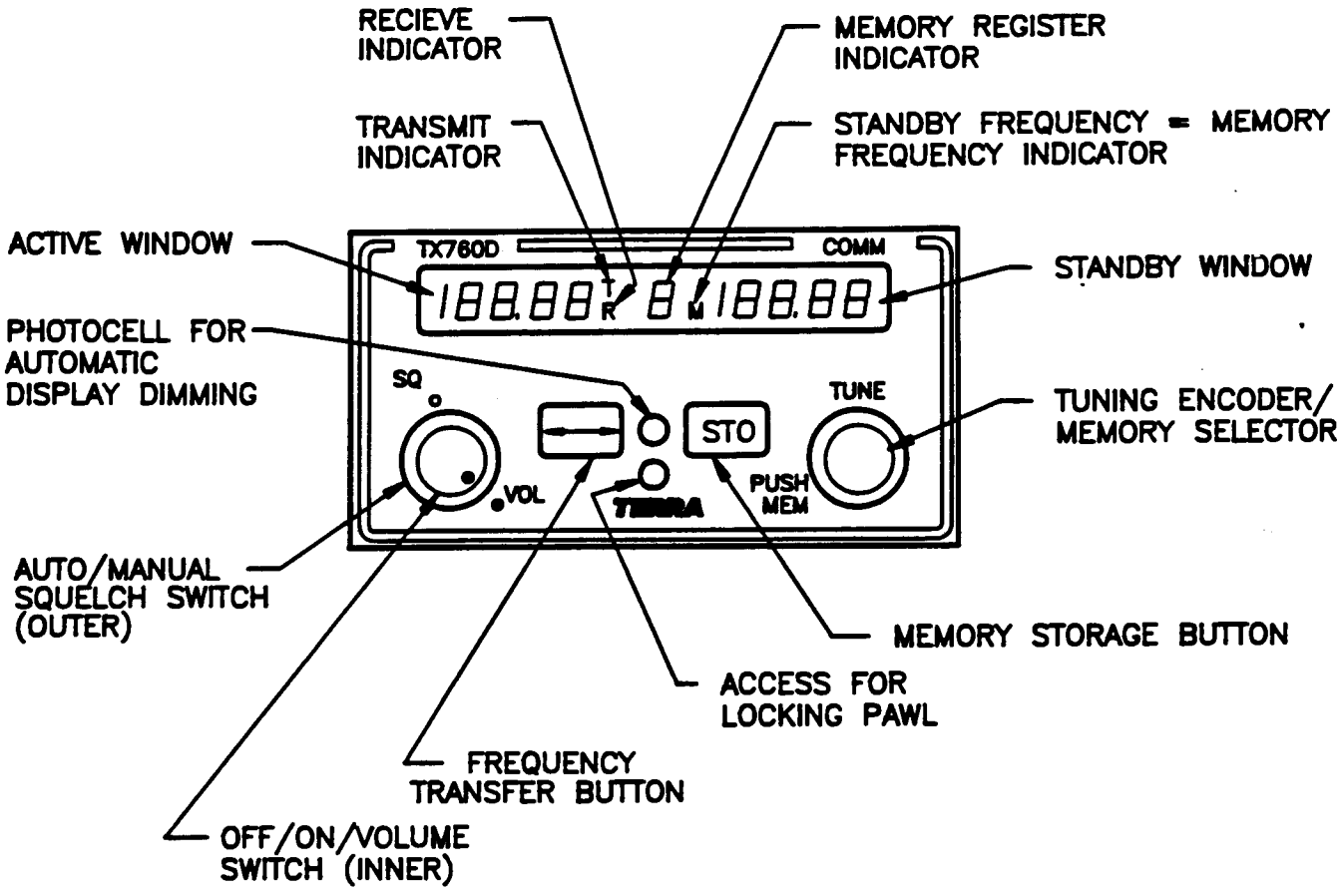
There are two failure mode annunciations incorporated in your TX 760D. Should the left-hand display start flashing and the code 01 appear in the right-hand display, the synthesizer is not tuned and will not channel the unit. Power down, wait 5 seconds, and power up. If the unit will not reset, service is required.

If the same indication is observed and the code 02 is displayed, the unit has shut down due to the transmission time exceeding three minutes, as would be encountered with a stuck mic key. Power down, wait one minute, power up. If the "T" is seen to the right side of the active display, the mic keyline is stuck.

4.12 SAFEGUARDS OPERATION

In order to remind the operator that the unit is receiving and the volume may not be turned up, an "R" is displayed to the right of the active display. This "R" will come on anytime a signal is being received or squelch is "broken".

Also to remind the operator, a "T" will be displayed any time the unit is in the transmit mode.


RECIEVE INDICATOR
MEMORY REGISTER INDICATOR
TRANSMIT INDICATOR
STANDBY FREQUENCY = MEMORY FREQUENCY INDICATOR
ACTIVE WINDOW
TX760D
COMM
STANDBY WINDOW
PHOTOCELL FOR AUTOMATIC DISPLAY DIMMING
SQ
TUNE
TUNING ENCODER/ MEMORY SELECTOR
STO
VOL
TERRA
PUSH MEM
AUTO/MANUAL SQUELCH SWITCH (OUTER)
MEMORY STORAGE BUTTON
ACCESS FOR LOCKING PAWL
FREQUENCY TRANSFER BUTTON
OFF/ON/VOLUME SWITCH (INNER)

| | | |

Avionics

Products

Terra by Trimble TRT 250D
Transponder

A transponder certified to category C74C Class 2A, offering state-of-the-art solid miniature microwave technology

Having an aircraft that is transponder-equipped makes you easily identifiable by ground radar. It also opens up more airspace for your operations. Air Traffic Control is able to offer transponder-equipped aircraft higher levels of service, separation, and safety. This is a must when flying in today's crowded airspace.

The Terra by Trimble TRT 250D Mode C capable transponder is fully TSO'd to Class 2A and approved for use in all general aviation and regional airline aircraft. It features a brilliant planar gas discharge display which is clearly visible, even in bright sunlight. Also, as with all Terra by Trimble radios, the 250D has an automatic dimming feature which adjusts for all lighting conditions.

With the TRT 250D, you can select transponder codes with the single-knob cursor tuning. A unique Terra by Trimble feature also allows you to directly squawk VFR with a simple push of the VFR button. In addition, this unit simultaneously displays active and standby codes which you can transfer with a touch of a button.

For reliability and ruggedness in all conditions, the TRT 250D uses the latest surface-mount components. The TRT 250D's advanced design also incorporates state-of-the-art LSI computer architecture and miniature microwave technology. This eliminates the expensive cavity tube transmitter found in lesser designs; another Terra by Trimble Technology Advantage.

Like all of its radios, Terra by Trimble houses the TRT 250D in a stainless steel mounting tray in either a single- or dual-mount chassis. You can also purchase an optional chassis that mounts into a standard 3" ATI cutout.

The TRT 250D is the smallest transponder with the biggest features including affordability and innovative technology which keeps you seen and headed in the right direction.

Altitude Digitizer AT 3000:
Your altitude is automatically reported with the AT 3000 Altitude Digitizer. This solid state blind encoding altimeter is designed to interface with the Terra by Trimble TRT 250D transponder as well as other Mode C transponders. The addition of the AT 3000 to any transponder provides the altitude reporting capability that is required when you need to fly in today's complex airspace.

Key Features and Benefits

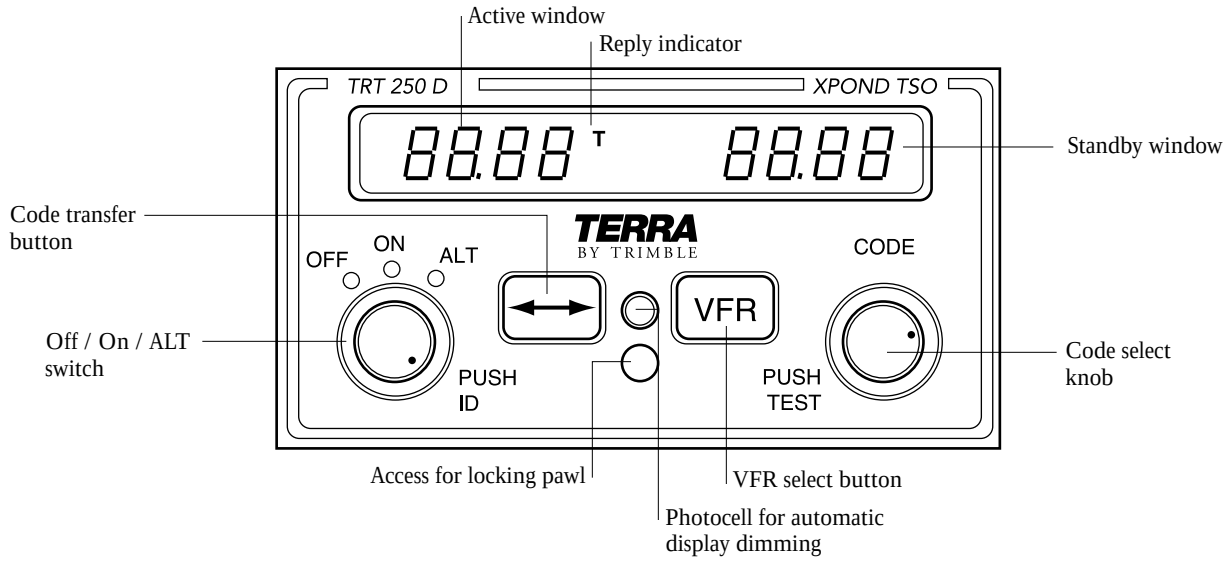
- Highly visible gas discharge display
- Easy-to-use single-knob cursor tuning
- One-touch Squawk VFR
- 10 frequency memory reduces pilot workload
- Small and lightweight, easy-to-install
- Air show proven, rugged and reliable
- Optional 40 channel glideslope receiver
- TSO'd
- Unparalleled three year warranty

TERRA
BY TRIMBLE

Terra by Trimble TRT 250D

Transponder

Features



Technical Specifications

Transponder
- Planar gas discharge display
- Dual display, active/standby
- Single knob code selection
- Direct selection of user-selectable VFR code
- DME suppression input and output
- All solid-state circuitry—no cavity tube
- Transmit indicator light
- Automatic display check
- Approved for use in helicopters and turbine powered aircraft
- Includes mounting tray, antenna and connector kit
- Keep alive memory of last used active frequency

Transmit Frequency: 1090 MHz

Receive Frequency: 1030 MHz

Power Output: 200 watts nominal

Receiver Sensitivity: -72 dBm minumum

Power Requirements: 11 to 32 VDC, 0.75 amps max

Reply Modes:
A and C for air traffic control and altitude reporting

Code Capability:
4096 plus SPIP (ident)

Altitude: To 55,000 ft. MSL

Vibration:
Approved for all piston or turbine powered aircraft, balloons, sailplanes, helicopters

TSO Category: C74c Class 2A

Environmental Cat:
DO-160A/A1F1/A/PKS/ XXXXXXXBBBA

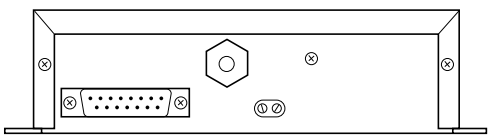
Size: 3.125"W; 1.6"H; 11.45"L (incl. mounting tray)

Weight: 1.84 lbs.

*D model Comms, Navs ADF's and Transponders are also available in a standard 3" ATI mount. Specifications subject to change without notice.

AT 3000 Altitude Digitizer • Blind Encoding Altimeter

Technical Specifications



Accuracy:
± 100 ft. nominal (measured at the digital altitude code transition point(s); tracking adjustments are provided to permit matching for correspondence with the aircraft altimeter.)

Altitude Range: -1,000 to +30,000 ft. maximum operating range

Operating Temperature: -20°C to +55°C

Input Power: 11 to 32 VDC, 160 mA at 14 VDC; 80 mA at 28 VDC

TSO'd to C88

Size: 2.55"W; 1.65"H; 7.25"L

Weight: 0.5 lbs.

Trimble
THE GPS SOLUTION

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U.S. Department
of Transportation

Federal Aviation
Administration

FAA-H-8083-23

Seaplane, Skiplane, and Float/Ski Equipped Helicopter Operations Handbook

SEAPLANE, SKIPLANE, and FLOAT/SKI EQUIPPED HELICOPTER OPERATIONS HANDBOOK

2004

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Flight Standards Service

PREFACE

This operational handbook introduces the basic skills necessary for piloting seaplanes, skiplanes, and helicopters equipped with floats or skis. It is developed by the Flight Standards Service, Airman Testing Standards Branch, in cooperation with various aviation educators and industry.

This handbook is primarily intended to assist pilots who already hold private or commercial certificates and who are learning to fly seaplanes, skiplanes, or helicopters equipped for water or ski operations. It is also beneficial to rated seaplane pilots who wish to improve their proficiency, pilots preparing for flights using ski equipped aircraft, and flight instructors engaged in the instruction of both student and transitioning pilots. It introduces the future seaplane or skiplane pilot to the realm of water operations and cold weather operations, and provides information on the performance of procedures required for the addition of a sea class rating in airplanes. Information on general piloting skills, aeronautical knowledge, or flying techniques not directly related to water or cold weather operations are beyond the scope of this book, but are available in other Federal Aviation Administration (FAA) publications.

This handbook conforms to pilot training and certification concepts established by the FAA. There are different ways of teaching, as well as performing specific operating procedures, and many variations in the explanations of operating from water, snow, and ice. This handbook is not comprehensive, but provides a basic knowledge that can serve as a foundation on which to build further knowledge. The discussion and explanations reflect commonly used practices and principles. Occasionally the word "must" or similar language is used where the desired action is deemed critical. The use of such language is not intended to add to, interpret, or relieve a duty imposed by Title 14 of the Code of Federal Regulations (14 CFR).

It is essential for persons using this handbook to also become familiar with and apply the pertinent parts of 14 CFR and the *Aeronautical Information Manual (AIM).* The AIM is available online at **http://www.faa.gov/atpubs**. Performance standards for demonstrating competence required for the seaplane rating are prescribed in the appropriate practical test standard.

The current Flight Standards Service airman training and testing material and subject matter knowledge codes for all airman certificates and ratings can be obtained from the Flight Standards Service web site at **http://av-info.faa.gov**.

The FAA greatly appreciates the valuable assistance provided by many individuals and organizations throughout the aviation community whose expertise contributed to the preparation of this handbook.

This handbook supercedes Chapters 16 and 17 of FAA-H-8083-3, *Airplane Flying Handbook*, dated 1999. This handbook is available for download from the Flight Standards Service Web site at **http://av-info.faa.gov.** This Web site also provides information about availability of printed copies.

This handbook is published by the U.S. Department of Transportation, Federal Aviation Administration, Airman Testing Standards Branch, AFS-630, P.O. Box 25082, Oklahoma City, OK 73125. Comments regarding this handbook should be sent in e-mail form to **AFS630comments@faa.gov**.

AC 00-2, *Advisory Circular Checklist*, transmits the current status of FAA advisory circulars and other flight information and publications. This checklist is available via the Internet at **http://www.faa.gov/aba/html_policies/ac00_2.html.**

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Chapter 1

Rules, Regulations, and Aids for Navigation

PRIVILEGES AND LIMITATIONS

In general, the privileges and limitations of a seaplane rating are similar to those of the equivalent land rating. The same standards and requirements apply as for comparable landplane certificates.

While it is possible for a student to use a seaplane to obtain all the flight training necessary to earn a pilot certificate, and many pilots have done so, this publication is intended primarily for pilots who already hold airman certificates and would like to add seaplane capabilities. Therefore, this chapter does not address pilot certificate requirements, regulations, or procedures that would also apply to landplane operations. Information on regulations not directly related to water operations is available in other Federal Aviation Administration (FAA) publications.

For certification purposes, the term "seaplane" refers to a class of aircraft. A pilot requires additional training when transitioning to a seaplane. Ground and flight training must be received and logged, and a pilot must pass a class rating practical test prior to initial operations as pilot in command. This training requires the use of an authorized flight instructor to conduct such training and attest to the competency of a pilot prior to taking the practical test. Because the seaplane rating is part of an existing pilot certificate, the practical test is not as extensive as for a new pilot certificate, and covers only the procedures unique to seaplane operations. No separate written test is required for pilots who are adding seaplane to an existing pilot certificate.

Adding a seaplane rating does not modify the overall limitations and privileges of the pilot certificate. For example, private pilots with a seaplane rating are not authorized to engage in seaplane operations that would require a commercial certificate. Likewise, a pilot with a single-engine seaplane class rating may not fly multiengine seaplanes without further training. However, no regulatory distinction is made between flying boats and seaplanes equipped with floats. [Figure 1-1]

SEAPLANE REGULATIONS

Because of the nature of seaplane operations, certain regulations apply. Most of them are set forth in Title 14

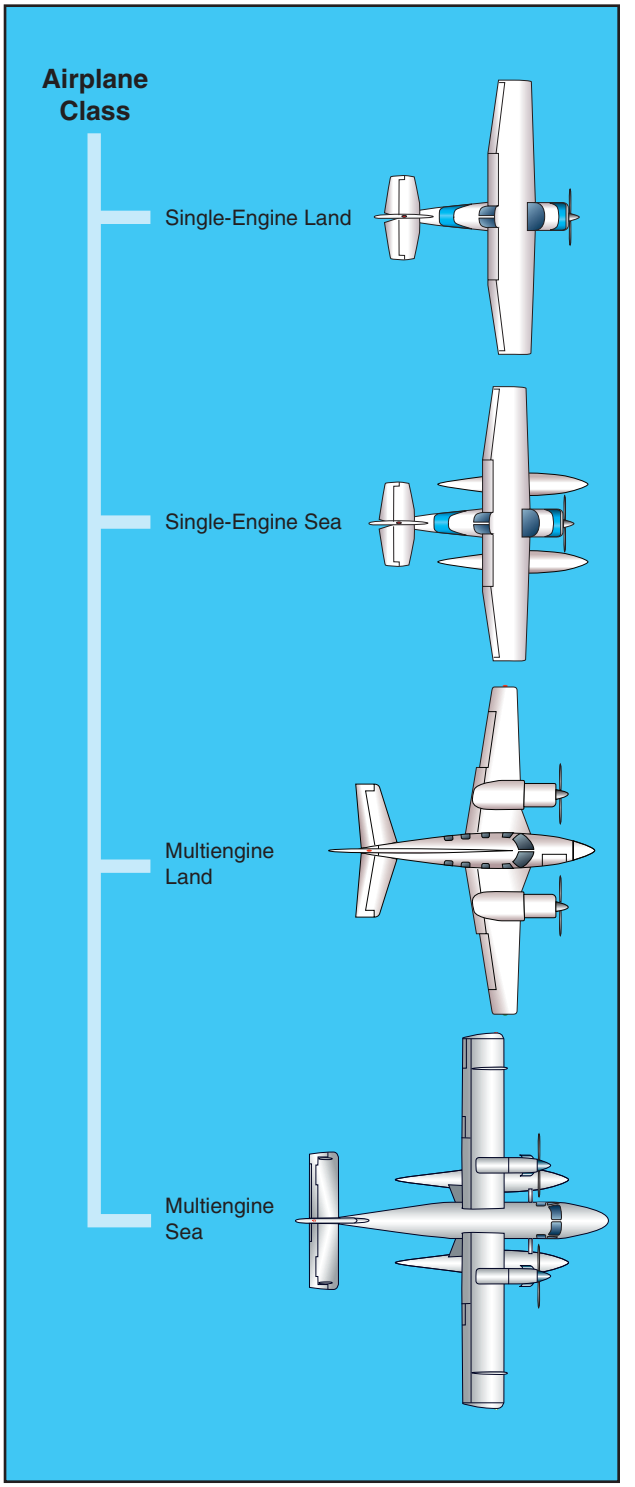


Figure 1-1. Seaplane is a class.

of the Code of Federal Regulations (14 CFR) parts 1, 61, and 91.

Just as land-based pilots must understand airport operations, the pilot certification requirements in 14 CFR part 61 require seaplane pilots to know and use the rules for seaplane base operations.

Specific regulations recognize the unique characteristics of water operations. For example, 14 CFR part 61, section 61.31 takes into account that seaplanes seldom have retractable landing gear as such, so an endorsement to act as pilot in command of a complex seaplane requires training in a seaplane with flaps and a controllable pitch propeller. Likewise, in 14 CFR part 91, section 91.107, there is an exception to the rule that everyone must have a seat and wear a seatbelt during movement on the surface. The person pushing off or mooring a seaplane at a dock is authorized to move around while the seaplane is in motion on the surface.

14 CFR PART 91, SECTION 91.115 RIGHT-OF-WAY RULES: WATER OPERATIONS

The right-of-way rules for operation on water are similar, but not identical, to the rules governing right-of-way between aircraft in flight.

(a) General. Each person operating an aircraft on the water shall, insofar as possible, keep clear of all vessels and avoid impeding their navigation, and shall give way to any vessel or other aircraft that is given the right-of-way by any rule of this section.

(b) Crossing. When aircraft, or an aircraft and a vessel, are on crossing courses, the aircraft or vessel to the other's right has the right-of-way.

(c) Approaching head-on. When aircraft, or an aircraft and a vessel, are approaching head-on, or nearly so, each shall alter its course to the right to keep well clear.

(d) Overtaking. Each aircraft or vessel that is being overtaken has the right-of-way, and the one overtaking shall alter course to keep well clear.

(e) Special circumstances. When aircraft, or an aircraft and a vessel, approach so as to involve risk of collision, each aircraft or vessel shall proceed with careful regard to existing circumstances, including the limitations of the respective craft.

RULES OF THE SEA

According to United States Coast Guard (USCG) regulations, the definition of a vessel includes virtually anything capable of being used for transportation on water, including seaplanes on the water. Therefore, any time a seaplane is operating on the water, whether under power or not, it is required to comply with USCG navigation rules applicable to vessels. Simply adhering to 14 CFR part 91, section 91.115 should ensure compliance with the USCG rules. Pilots are encouraged to obtain the USCG Navigation Rules, International-Inland, M16672.2D, available from the U.S. Government Printing Office. These rules apply to all public or private vessels navigating upon the high seas and certain inland waters.

INLAND AND INTERNATIONAL WATERS

Inland waters are divided visually from international waters by buoys in areas with frequent ocean traffic. Inland waters are inshore of a line approximately parallel with the general trend of the shore, drawn through the outermost buoy. The waters outside of the line are international waters or the high seas.

Seaplanes operating inshore of the boundary line dividing the high seas from the inland waters must follow the established statutory Inland Rules (Pilot Rules). Seaplanes navigating outside the boundary line dividing the high seas from inland waters must follow the International Rules of the Sea. All seaplanes must carry a current copy of the rules when operating in international waters.

UNITED STATES AIDS FOR MARINE NAVIGATION

For safe operations, a pilot must be familiar with seaplane bases, maritime rules, and aids to marine navigation.

SEAPLANE LANDING AREAS

The familiar rotating beacon is used to identify lighted seaplane landing areas at night and during periods of reduced visibility; however, the colors alternate white and yellow for water landing areas. A double white flash alternating with yellow identifies a military seaplane base.

On aeronautical charts, seaplane landing areas are depicted with symbols similar to land airports, with the addition of an anchor in the center. As with their land counterparts, tick marks around the outside of the symbol denote a seaplane base with fuel and services available, and a double ring identifies military facilities. [Figure 1-2]

BUOYS AND DAYBEACONS

Buoys are floating markers held in place with cables or chains to the bottom. Daybeacons are used for similar purposes in shallower waters, and usually consist of a marker placed on top of a piling or pole driven into the bottom. Locations of buoys within U.S. waters are

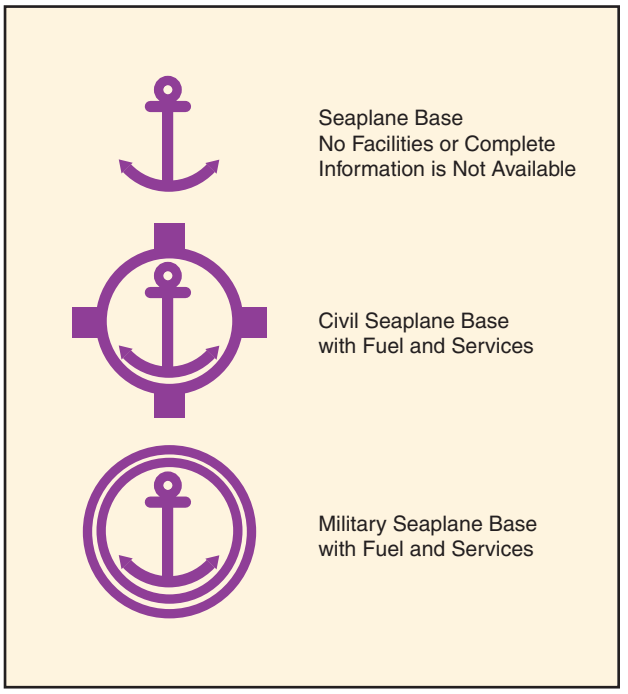


Figure 1-2. Seaplane landing areas have distinctive symbols to distinguish them from land airports.

shown on nautical charts prepared by the Office of Coast Survey (OCS), an office within the National Oceanic and Atmospheric Administration (NOAA). Light lists prepared by the Coast Guard describe lightships, lighthouses, buoys, and daybeacons maintained on all navigable waters of the United States.

The buoyage system used in the United States employs a simple arrangement of colors, shapes, numbers, and lights. Whenever operating near buoys, keep in mind that the length of chain holding the buoy in place is likely to be several times the depth of the water, so the buoy may be some distance from its charted location, as well as from any danger or obstruction it is intended to mark. Do not come any closer to a buoy than necessary.

Buoys with a cylindrical shape are called can buoys, while those with a conical shape are known as nun buoys. The shape often has significance in interpreting the meaning of the buoy. [Figure 1-3]

Since a buoy's primary purpose is to guide ships through preferred channels to and from the open sea, the colors, shapes, lights, and placement become meaningful in that context. Approaching from seaward, the left (port) side of the channel is marked with black or green can buoys. These buoys use odd numbers whose values increase as the vessel moves toward the coast. They also mark obstructions that should be kept to the vessel's left when proceeding from seaward.

The right side of the channel, or obstructions that should be kept to the vessel's right when headed toward shore, are marked with red nun buoys. These

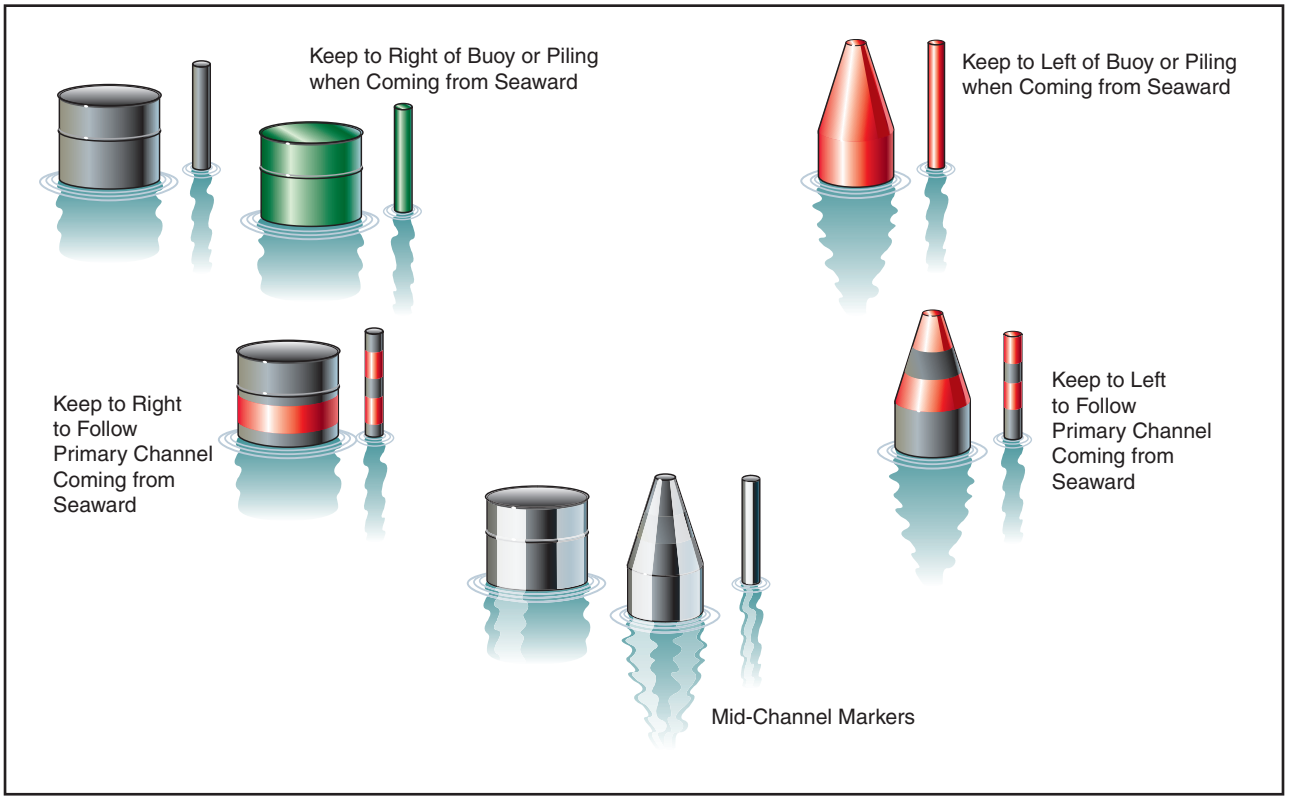


Figure 1-3. Buoys typically used along waterways.

buoys use even numbers whose values increase from seaward. The mnemonic "red, right, returning" helps mariners and seaplane pilots remember to keep the red buoys to their right when proceeding toward the shore ("returning" to their home port).

Black and white vertically striped buoys mark the center of the channel or fairway (the nautical term for the navigable part of a river, bay, or harbor), and may use letters starting at A from seaward.

Naturally, not all waterways lead straight from ocean to port, so there are also buoys to mark the junctions of waterways. Buoys with red and black horizontal bands mark junctions or places where the waterway forks. They also mark wrecks and obstructions that can be passed on either side. The color of the top band (red or black) and the shape of the buoy (nun or can) indicate the side on which the buoy should be passed by a vessel proceeding inbound along the primary channel. If the topmost band is black, the buoy should be kept to the left of an inbound vessel. If the topmost band is red, keep the buoy to the right when inbound. Buoys with the black top band will usually be cans, while those with the red top band will usually be nuns.

For waterways that run more or less parallel to the coast, there is no obvious inbound or outbound to give direction to the waterway, so by convention the inbound direction of such waterways is assumed to be "clockwise" around the contiguous states. This means that for waterways running parallel to the east coast, southbound is considered the inbound direction; for waterways along the Gulf coast, inbound means westbound; and for waterways along the west coast, northbound is inbound.

Daybeacons and daymarks serve similar purposes as buoys and use similar symbology. In the United States, green is replacing black as the preferred color for portside daymarks. [Figure 1-4]

These are just the most basic features of the most common buoyage system in the United States. There are other buoyage systems in use, both in the United States and in other countries. Sometimes the markings are exactly the opposite of those just described. Good pilots will obtain a thorough understanding of the maritime aids to navigation used in the areas where they intend to fly.

NIGHTTIME BUOY IDENTIFICATION

Usually only the more important buoys are lighted. Some unlighted buoys may have red, white, or green reflectors having the same significance as lights of the same colors. Black or green buoys have green or white lights; red buoys have red or white lights. Likewise, buoys with a red band at the top carry red lights, while those with a black band topmost carry green lights. White lights are used without any color significance. Lights on red or black buoys are always flashing or occulting. (When the light period is shorter than the dark period, the light is flashing. When the light is interrupted by short dark periods, the light is occulting.) A light flashing a Morse Code letter "A" (dot-dash) indicates a mid-channel buoy.

There is much more to the system of maritime navigation aids than can be presented here. Nautical books and online resources can be a great help in extending knowledge and understanding of these important aids.

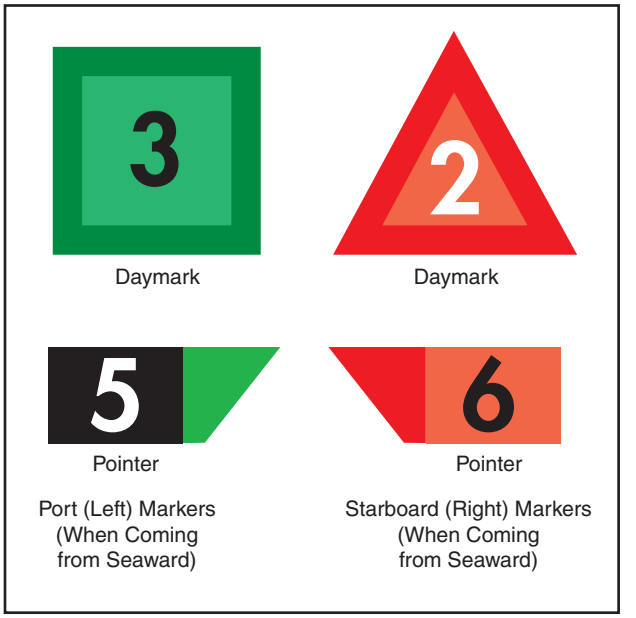


Figure 1-4. Typical daymarks.

Chapter 2

Principles of Seaplanes

SEAPLANE CHARACTERISTICS

There are two main types of seaplane: flying boats (often called hull seaplanes) and floatplanes. The bottom of a **flying boat**'s fuselage is its main landing gear. This is usually supplemented with smaller floats near the wingtips, called **wing or tip floats**. Some flying boats have **sponsons**, which are short, winglike projections from the sides of the hull near the waterline. Their purpose is to stabilize the hull from rolling motion when the flying boat is on the water, and they may also provide some aerodynamic lift in flight. Tip floats are sometimes known as sponsons. The hull of a flying boat holds the crew, passengers, and cargo; it has many features in common with the hull of a ship or boat. On the other hand, **floatplanes** typically are conventional landplanes that have been fitted with separate floats (sometimes called pontoons) in place of their wheels. The fuselage of a floatplane is supported well above the water's surface.

Some flying boats and floatplanes are equipped with retractable wheels for landing on dry land. These aircraft are called **amphibians**. On amphibious flying boats, the main wheels generally retract into the sides of the hull above the waterline. The main wheels for amphibious floats retract upward into the floats themselves, just behind the step. Additional training is suggested for anyone transitioning from straight floats to amphibious aircraft. [Figure 2-1]

There are considerable differences between handling a floatplane and a flying boat on the water, but similar principles govern the procedures and techniques for both. This book primarily deals with floatplane

Figure 2-1. Flying boats, floatplanes, and amphibians.

operations, but with few exceptions, the explanations given here also apply to flying boats.

A number of amphibious hull seaplanes have their engines mounted above the fuselage. These seaplanes have unique handling characteristics both on the water and in the air. Because the thrust line is well above the center of drag, these airplanes tend to nose down when power is applied and nose up as power is reduced. This response is the opposite of what pilots have come to expect in most other airplanes, and can lead to unexpected pitch changes and dangerous situations if the pilot is not thoroughly familiar with these characteristics. Pilots transitioning to a seaplane with this configuration should have additional training.

Many of the terms that describe seaplane hulls and floats come directly from the nomenclature of boats and ships. Some of these terms may already be familiar, but they have specific meanings when applied to seaplanes. Figures 2-2 and 2-3 describe basic terms, and the glossary at the end of this book defines additional terms.

Other nautical terms are commonly used when operating seaplanes, such as port and starboard for left and right, windward and leeward for the upwind and downwind sides of objects, and bow and stern for the front and rear ends of objects.

Research and experience have improved float and hull designs over the years. Construction and materials have changed, always favoring strength and light weight. Floats and hulls are carefully designed to optimize hydrodynamic and aerodynamic performance.

Floats usually have bottoms, sides, and tops. A strong **keel** runs the length of the float along the center of the bottom. Besides supporting the seaplane on land, the keel serves the same purpose as the keel of a boat when the seaplane is in the water. It guides the float in a straight line through the water and resists sideways motion. A short, strong extension of the keel directly behind the step is called the **skeg**. The **chine** is the seam where the sides of the float are joined to the bottom. The chine helps guide water out and away from the float, reducing spray and helping with **hydrodynamic** lift. Hydrodynamic forces are those that result from motion in fluids.

On the front portion of the float, midway between the keel and chine, are the two **sister keelsons**. These longitudinal members add strength to the structure and function as additional keels. The top of the float forms a **deck** that provides access for entering and leaving the cabin. Bilge pump openings, hand hole covers, and cleats for mooring the seaplane are typically located along the deck. The front of each float has a rubber bumper to cushion minor impacts with docks, etc. Many floats also have **spray rails** along the inboard forward portions of the chines. Since water spray is surprisingly destructive to propellers, especially at high r.p.m., these metal flanges are designed to reduce the amount of spray hitting the propeller.

Floats are rated according to the amount of weight they can support, which is based on the weight of the actual volume of fresh water they displace. Fresh water is the standard because sea water is about 3 percent denser than fresh water and can therefore support more weight. If a particular float design displaces 2,500 pounds of fresh water when the float is pushed under the surface, the float can nominally support 2,500

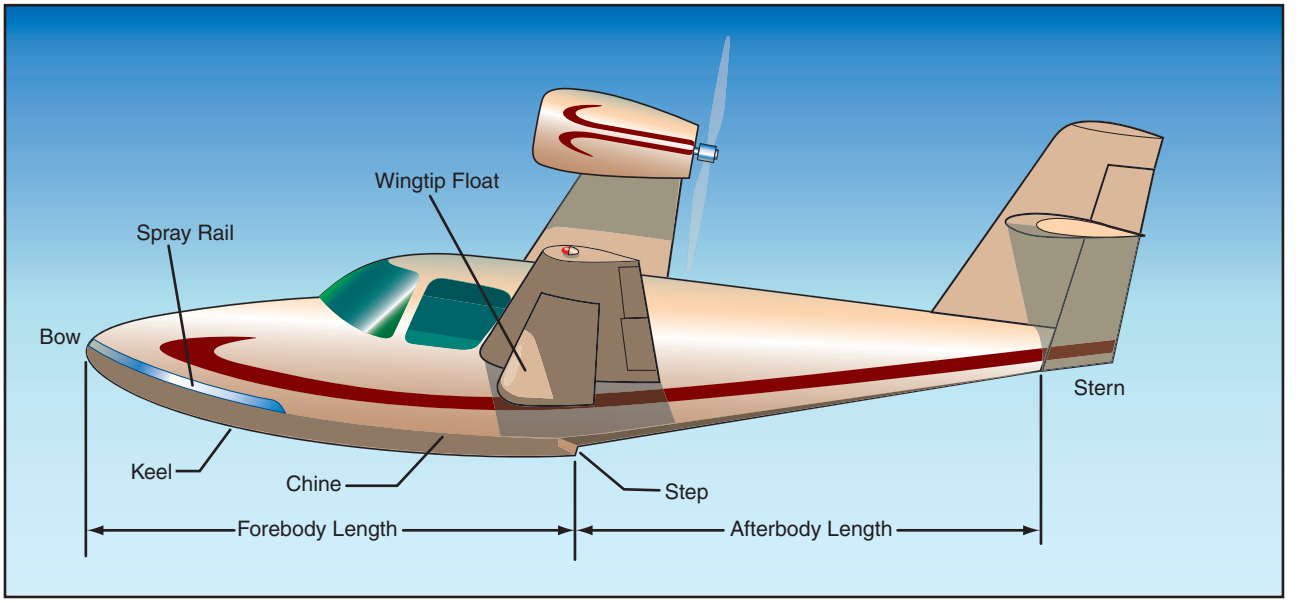


Figure 2-2. Hull components.

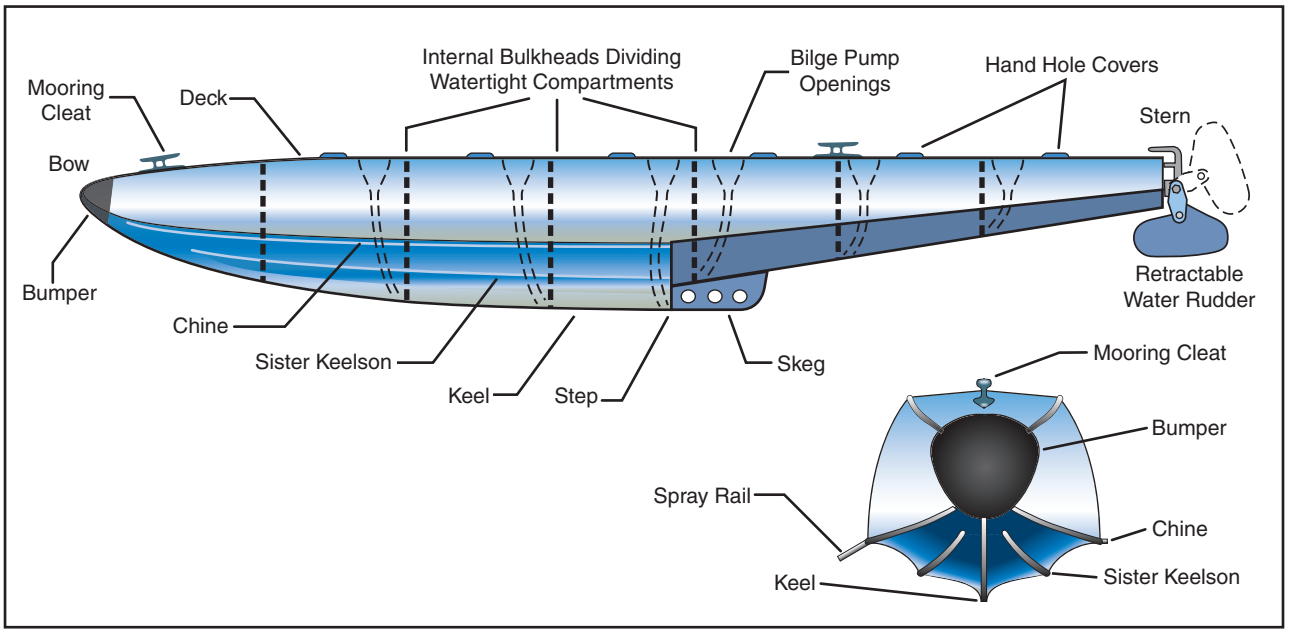


Figure 2-3. Float components.

pounds. A seaplane equipped with two such floats would seemingly be able to support an airplane weighing 5,000 pounds, but the floats would both be completely submerged at that weight. Obviously, such a situation would be impractical, so seaplanes are required to have a buoyancy of 80 percent in excess of that required to support the maximum weight of the seaplane in fresh water. To determine the maximum weight allowed for a seaplane equipped with two floats, divide the total displacement by 180 percent, or 1.8. Using the example of two floats that each displace 2,500 pounds, the total displacement of 5,000 pounds divided by 1.8 gives a maximum weight for the seaplane of 2,778 pounds. Many other considerations determine the suitability of a particular set of floats for a specific type of airplane, and float installations are carefully evaluated by the Federal Aviation Administration (FAA) prior to certification.

All floats are required to have at least four watertight compartments. These prevent the entire float from filling with water if it is ruptured at any point. The floats can support the seaplane with any two compartments flooded, which makes the seaplane difficult to sink.

Most floats have openings with watertight covers along the deck to provide access to the inside of each compartment for inspection and maintenance. There are also smaller holes connected by tubes to the lowest point in each compartment, called the bilge. These bilge pump openings are used for pumping out the bilge water that leaks into the float. The openings are typically closed with small rubber balls that push snugly into place.

Both the lateral and longitudinal lines of a float or hull are designed to achieve a maximum lifting force by diverting the water and the air downward. The forward bottom portion of a float or hull is designed very much like the bottom of a speedboat. While speedboats are intended to travel at a fairly constant pitch angle, seaplanes need to be able to rotate in pitch to vary the wings' angle of attack and increase lift for takeoffs and landings. The underside of a seaplane float has a sudden break in the longitudinal lines called the **step**. The step provides a means of reducing water drag during takeoff and during high-speed taxi.

At very low speeds, the entire length of the floats supports the weight of the seaplane through buoyancy, that is, the floats displace a weight of water equal to the weight of the seaplane. As speed increases, aerodynamic lift begins to support a certain amount of the weight, and the rest is supported by hydrodynamic lift, the upward force produced by the motion of the floats through the water. Speed increases this hydrodynamic lift, but water drag increases more quickly. To minimize water drag while allowing hydrodynamic lift to do the work of supporting the seaplane on the water, the pilot relaxes elevator back pressure, allowing the seaplane to assume a pitch attitude that brings the aft portions of the floats out of the water. The step makes this possible. When running on the step, a relatively small portion of the float ahead of the step supports the seaplane. Without a step, the flow of water aft along the float would tend to remain attached all the way to the rear of the float, creating unnecessary drag.

The steps are located slightly behind the airplane's center of gravity (CG), approximately at the point where the main wheels are located on a landplane

with tricycle gear. If the steps were located too far aft or forward of this point, it would be difficult, if not impossible, to rotate the airplane into a nose-up attitude prior to lifting off. Although steps are necessary, the sharp break along the underside of the float or hull concentrates structural stress into this area, and the disruption in airflow produces considerable drag in flight. The keel under the front portion of each float is intended to bear the weight of the seaplane when it is on dry land. The location of the step near the CG would make it very easy to tip the seaplane back onto the rear of the floats, which are not designed for such loads. The skeg is located behind the step and acts as a sort of chock when the seaplane is on land, making it more difficult to tip the seaplane backward.

Most floatplanes are equipped with retractable **water rudders** at the rear tip of each float. The water rudders are connected by cables and springs to the rudder pedals in the cockpit. While they are very useful in maneuvering on the water surface, they are quite susceptible to damage. The water rudders should be retracted whenever the seaplane is in shallow water or where they might hit objects under the water surface. They are also retracted during takeoff and landing, when dynamic water forces could cause damage.

SEAPLANE FLIGHT PRINCIPLES

In the air, seaplanes fly much like landplanes. The additional weight and drag of the floats decrease the airplane's useful load and performance compared to the same airplane with wheels installed. On many airplanes, directional stability is affected to some extent by the installation of floats. This is caused by the length of the floats and the location of their vertical surface area in relation to the airplane's CG. Because the floats present such a large vertical area ahead of the CG, they may tend to increase any yaw or sideslip. To help restore directional stability, an auxiliary fin is often added to the tail. Less aileron pressure is needed to hold the seaplane in a slip. Holding some rudder pressure may be required to maintain coordination in turns, since the cables and springs for the water rudders may tend to prevent the air rudder from streamlining in a turn.

Chapter 3

Water Characteristics and Seaplane Base Operations

CHARACTERISTICS OF WATER

A competent seaplane pilot is knowledgeable in the characteristics of water and how they affect the seaplane. As a fluid, water seeks its own level, and forms a flat, glassy surface if undisturbed. Winds, currents, or objects traveling along its surface create waves and movements that change the surface characteristics.

Just as airplanes encounter resistance in the form of drag as they move through the air, seaplane hulls and floats respond to drag forces as they move through water. Drag varies proportionately to the square of speed. In other words, doubling the seaplane's speed across the water results in four times the drag force.

Forces created when operating an airplane on water are more complex than those created on land. For landplanes, friction acts at specific points where the tires meet the ground. Water forces act along the entire length of a seaplane's floats or hull. These forces vary constantly depending on the pitch attitude, the changing motion of the float or hull, and action of the waves. Because floats are mounted rigidly to the structure of the fuselage, they provide no shock absorbing function, unlike the landing gear of landplanes. While water may seem soft and yielding, damaging forces and shocks can be transmitted directly through the floats and struts to the basic structure of the airplane.

Under calm wind conditions, the smooth water surface presents a uniform appearance from above, somewhat like a mirror. This situation eliminates visual references for the pilot and can be extremely deceptive. If waves are decaying and setting up certain patterns, or if clouds are reflected from the water surface, the resulting distortions can be confusing even for experienced seaplane pilots.

DETERMINING SEA CONDITIONS

The ability to read the water's surface is an integral part of seaplane flying. The interaction of wind and water determine the surface conditions, while tides and currents affect the movement of the water itself. Features along the shore and under the water's surface contribute their effects as well. With a little study, the interplay between these factors becomes clearer.

A few simple terms describe the anatomy and characteristics of waves. The top of a wave is the **crest**, and the low valley between waves is a **trough**. The height of waves is measured from the bottom of the trough to the top of the crest. Naturally, the distance between two wave crests is the wavelength. The time interval between the passage of two successive wave crests at a fixed point is the period of the wave.

Waves are usually caused by wind moving across the surface of the water. As the air pushes the water, ripples form. These ripples become waves in strong or sustained winds; the higher the speed of the wind, or the longer the wind acts on them, the larger the waves. Waves can be caused by other factors, such as underwater earthquakes, volcanic eruptions, or tidal movement, but wind is the primary cause of most waves. [Figure 3-1 on next page]

Calm water begins to show wave motion when the wind reaches about two knots. At this windspeed, patches of ripples begin to form. If the wind stops, surface tension and gravity quickly damp the waves, and the surface returns to its flat, glassy condition. If the wind increases to four knots, the ripples become small waves, which move in the same direction as the wind and persist for some time after the wind stops blowing.

As windspeed increases above four knots, the water surface becomes covered with a complicated pattern of waves. When the wind is increasing, waves become larger and travel faster. If the wind remains at a constant speed, waves develop into a series of evenly spaced parallel crests of the same height.

In simple waves, an object floating on the surface shows that waves are primarily an up and down motion of the water, rather than the water itself moving downwind at the speed of the waves. The floating object describes a circle in the vertical plane, moving upward as the crest approaches, forward and downward as the crest passes, and backward as the trough passes. After each wave passes, the object is at almost the same place as before. The wind does cause floating objects to drift slowly downwind.

While the wind is blowing and adding energy to the water, the resulting waves are commonly referred to as wind waves or **sea**. (Sea is also occasionally used

Terms Used by U.S. Weather Service	Velocity m.p.h.	Estimating Velocities on Land	Estimating Velocities on Sea	
Calm	Less than 1	Smoke rises vertically.	Sea like a mirror.	Check your glassy water technique before water flying under these conditions.
Light Air	1 - 3	Smoke drifts; wind vanes unmoved.	Ripples with the appearance of scales are formed but without foam crests.	
Light Breeze	4 - 7	Wind felt on face; leaves rustle; ordinary vane moves by wind.	Small wavelets, still short but more pronounced; crests have a glassy appearance and do not break.	
Gentle Breeze	8 - 12	Leaves and small twigs in constant motion; wind extends light flag.	Large wavelets; crests begin to break. Foam of glassy appearance. (Perhaps scattered whitecaps.)	Ideal water flying characteristics in protected water.
Moderate Breeze	13 - 18	Dust and loose paper raised; small branches are moved.	Small waves, becoming longer; fairly frequent whitecaps.	
Fresh Breeze	19 - 24	Small trees begin to sway; crested wavelets form in inland water.	Moderate waves; taking a more pronounced long form; many whitecaps are formed. (Chance of some spray.)	This is considered rough water for seaplanes and small amphibians, especially in open water.
Strong Breeze	25-31	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.	Large waves begin to form; white foam crests are more extensive everywhere. (Probably some spray.)	
Moderate Gale	32-38	Whole trees in motion; inconvenience felt in walking against the wind.	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.	This type of water condition is for emergency only in small aircraft in inland waters and for the expert pilot.

Figure 3-1. The size of waves is determined by the speed of the wind.

to describe the combined motion of all the factors disturbing the surface.) These waves tend to be a chaotic mix of heights, periods, and wavelengths. Because the wind causes the height to increase faster than the wavelength, they often have relatively steep, pointed crests and rounded troughs. With a windspeed of 12 knots, the waves begin to break at their crests and create foam.

The height of waves depends on three factors: windspeed, length of time the wind blows over the water, and the distance over which the wind acts on the water. As waves move away from the area where they were generated (called a **fetch**), they begin to sort themselves by height and period, becoming regular and evenly spaced. These waves often continue for thousands of miles from where they were generated. **Swell** is the term describing waves that persist outside the fetch or in the absence of the force that generated them. A swell may be large or small, and does not indicate the direction of the wind. The wake of a boat or ship is also a swell.

Unlike wind and current, waves are not deflected much by the rotation of the Earth, but move in the direction in which the generating wind blows. When this wind ceases, water friction and spreading reduce the wave height, but the reduction takes place so slowly that a swell persists until the waves encounter an obstruction, such as a shore. Swell systems from many different directions, even from different parts of the world, may cross each other and interact. Often two or more swell systems are visible on the surface, with a sea wave system developing due to the current wind.

In lakes and sheltered waters, it is often easy to tell wind direction by simply looking at the water's surface. There is usually a strip of calm water along the upwind shore of a lake. Waves are perpendicular to the wind direction. Windspeeds above approximately eight knots leave wind streaks on the water, which are parallel to the wind.

Land masses sculpt and channel the air as it moves over them, changing the wind direction and speed. Wind direction may change dramatically from one part of a lake or bay to another, and may even blow in opposite directions within a surprisingly short distance. Always pay attention to the various wind indicators in the area, especially when setting up for takeoff or landing.

While waves are simply an up and down undulation of the water surface, **currents** are horizontal movements of the water itself, such as the flow of water downstream in a river. Currents also exist in the oceans, where solar heating, the Earth's rotation, and tidal forces cause the ocean water to circulate.

WATER EFFECTS ON OPERATIONS

Compared to operations from typical hard-surface runways, taking off from and landing on water presents several added variables for the pilot to consider. Waves and swell not only create a rough or uneven surface, they also move, and their movement must be considered in addition to the wind direction. Likewise, currents create a situation in which the surface itself is actually moving. The pilot may decide to take off or land with or against the current, depending on the wind, the speed of the current, and the proximity of riverbanks or other obstructions.

While a landplane pilot can rely on windsocks and indicators adjacent to the runway, a seaplane pilot needs to be able to read wind direction and speed from the water itself. On the other hand, the landplane pilot may be restricted to operating in a certain direction because of the orientation of the runway, while the seaplane pilot can usually choose a takeoff or landing direction directly into the wind.

Even relatively small waves and swell can complicate seaplane operations. Takeoffs on rough water can subject the floats to hard pounding as they strike consecutive wave crests. Operating on the surface in rough conditions exposes the seaplane to forces that can potentially cause damage or, in some cases, overturn the seaplane. When a swell is not aligned with the wind, the pilot must weigh the dangers posed by the swell against limited crosswind capability, as well as pilot experience.

On the other hand, calm, glassy water presents a different set of challenges. Since the wind is calm, taxiing and docking are somewhat easier, but takeoffs and landings require special techniques. Takeoff distances may be longer because the wings get no extra lifting help from the wind. The floats seem to adhere more tenaciously to the glassy water surface. When landing, the flat, featureless surface makes it far more difficult to gauge altitude accurately, and reflections can create confusing optical illusions. The specific techniques for glassy water operations are covered in Chapter 4, Seaplane Operations–Preflight and Takeoffs, and Chapter 6, Seaplane Operations–Landing.

Tides are cause for concern when the airplane is beached or moored in shallow water. A rising tide can lift a beached seaplane and allow it to float out to sea if the airplane is not properly secured. Depending on the height of the tide and the topography of the beach, an outgoing tide could leave a beached seaplane stranded far from the water. [Figure 3-2]

Figure 3-2. An outgoing tide can leave a seaplane far from the water. A rising tide can cause a beached seaplane to float away.

Many of the operational differences between landplanes and seaplanes relate to the fact that seaplanes have no brakes. From the time a seaplane casts off, it is usually in continuous motion due to the wind and current, so the pilot must take deliberate action to control this movement. Often these forces can be used to the pilot's advantage to help move the seaplane as desired. Starting the engine, performing the engine runup, and completing most pre-takeoff checks are all accomplished while the seaplane is in motion. The seaplane continues moving after the engine is shut down, and this energy, along with the forces of wind and current, is typically used to coast the seaplane to the desired docking point.

As with land airplanes, the wind tends to make the airplane weathervane, or yaw, until the nose points into the wind. This tendency is usually negligible on landplanes with tricycle landing gear, more pronounced on those with conventional (tailwheel) gear, and very evident in seaplanes. The tendency to weathervane can usually be controlled by using the water rudders while taxiing, but the water rudders are typically retracted prior to takeoff. Weathervaning can create challenges in crosswind takeoffs and landings, as well as in docking or maneuvering in close quarters.

SEAPLANE BASE OPERATIONS

In the United States, rules governing where seaplanes may take off and land are generally left to state and local governments.

Some states and cities are very liberal in the laws regarding the operation of seaplanes on their lakes and waterways, while other states and cities may impose stringent restrictions. The Seaplane Pilots Association publishes the useful Water Landing Directory with information on seaplane facilities, landing areas, waterway use regulations, and local restrictions throughout the United States. Before operating a seaplane on public waters, contact the Parks and Wildlife Department of the state, the State Aeronautics Department, or other authorities to determine the local requirements. In any case, seaplane pilots should always avoid creating a nuisance in any area, particularly in congested marine areas or near swimming or boating facilities.

Established seaplane bases are shown on aeronautical charts and are listed in the Airport/Facility Directory. The facilities at seaplane bases vary greatly, but most include a hard surface ramp for launching, servicing facilities, and an area for mooring or hangaring seaplanes. Many marinas designed for boats also provide seaplane facilities.

Seaplanes often operate in areas with extensive recreational or commercial water traffic. The movements of faster craft, such as speedboats and jet-skis are unpredictable. People towing skiers may be focusing their attention behind the boat and fail to notice a landing seaplane. Swimmers may be nearly invisible, often with just their heads showing among the waves. There is no equivalent of the airport traffic pattern to govern boat traffic, and although right-of-way rules exist on the water, many watercraft operators are unaware of the limits of seaplane maneuverability and may assume that seaplanes will always be able to maneuver to avoid them. Many times, the seaplane itself is an object of curiosity, drawing water traffic in the form of interested onlookers.

When seaplane operations are conducted in bush country, regular or emergency facilities are often limited or nonexistent. The terrain and waterways are frequently hazardous, and any servicing becomes the individual pilot's responsibility. Prior to operating in an unfamiliar area away from established seaplane facilities, obtain the advice of FAA Accident Prevention Counselors or experienced seaplane pilots who are familiar with the area.

Chapter 4

Seaplane Operations - Preflight and Takeoffs

PREFLIGHT INSPECTION

Begin the preflight inspection with a thorough review of the existing local weather, destination weather, and water conditions. This weather evaluation should include the direction and speed of the wind to determine their effects on takeoffs, landings, and other water operations.

The preflight inspection of a seaplane is somewhat different from that of a landplane. Inspecting a seaplane on the water is complicated by the need to reposition the seaplane to gain access to all parts of the airframe. On the other hand, preflighting a seaplane on land may create certain challenges because the wings and tail surfaces may be out of reach and difficult to inspect when standing on the ground.

The following preflight description omits many items that are identical in landplanes and seaplanes in order to emphasize the differences between the two procedures. The process and the equipment to be checked vary from airplane to airplane, but the following description provides a general idea of the preflight inspection for a typical high wing, single-engine floatplane. As always, follow the procedures recommended in the Airplane Flight Manual (AFM) or Pilot's Operating Handbook (POH).

If the seaplane is in the water during the preflight, take a good look at how it sits on the surface. This can provide vital clues to the presence of water in the floats, as well as to the position of the center of gravity. Is the seaplane lower in the water than it should be, given its load? Is one wing lower than the other, or is one float riding noticeably lower in the water than the other? Are the sterns of the floats low in the water? If any of these signs are present, suspect a flooded float compartment or an improperly loaded seaplane. At more than 8 pounds per gallon, even a relatively small amount of water in a float compartment can seriously affect both useful load and center of gravity (CG).

In the cockpit, verify that the throttle is closed, the mixture control is full lean, and the magnetos and master switch are turned off. Lower the water rudders and check for any stiffness or binding in the action of the cables. Check that necessary marine and safety equipment, such as life vests, lines (ropes), anchors, and paddles are present, in good condition, and stowed correctly. Obtain the bilge pump and fuel sample cup.

Standing on the front of the float, inspect the propeller, forward fuselage, and wing. Check the usual items, working from the nose toward the tail. Water spray damage to the propeller looks similar to gravel damage, and must be corrected by a mechanic. Check the oil and fuel levels and sample the fuel, ensuring that it is the proper grade and free of contaminants. Naturally, the most likely contaminant in seaplane fuel tanks is water. Pay extra attention to the lubrication of all hinges. Not only does lubrication make movement easier, but a good coating of the proper lubricant keeps water out and prevents corrosion. Look for any blistering or bubbling of the paint, which may indicate corrosion of the metal underneath. Check the security of the float struts and their attachment fittings. Be careful moving along the float, and pay attention to wing struts, mooring lines, and other obstacles. If the seaplane is on land, do not stand on the floats aft of the step or the seaplane may tip back.

Next, inspect the float itself. Water forces can create very high loads and lead to cumulative damage. Look carefully for signs of stress, such as distortion or buckling of the skin, dents, or loose rivets. The chines should form a continuous smooth curve from front to back, and there should be no bends or kinks along the flange. If the floats are made of fiberglass or composite materials, look carefully for surface cracks, abrasions, or signs of delamination. Check the spreader bars between the floats, and look at the bracing wires and their fittings. Any sign of movement, loose fasteners, broken welds, or a bracing wire that is noticeably tighter or looser than the others is cause for concern. Check for signs of corrosion, especially if the seaplane has been operated in salt water. Although corrosion is

less of an issue with composite floats, be sure to check metal fittings and fasteners. [Figure 4-1]

Figure 4-1. A preflight inspection with the seaplane on land provides an opportunity to thoroughly examine the floats below the waterline. Note the spray rail on the inboard chine of the far float in this photo.

Use the bilge pump to remove any accumulated water from each watertight compartment. The high dynamic water pressure and the physical stresses of takeoffs and landings can momentarily open tiny gaps between float components, allowing small amounts of water to enter. Conversely, sitting idle in the water also results in a small amount of seepage and condensation. While it is normal to pump a modest amount of water from each compartment, more than a quart or so may indicate a problem that should be checked by a qualified aircraft mechanic experienced in working on floats. Normal is a relative term, and experience will indicate how much water is too much. [Figure 4-2]

Figure 4-2. Bilge pump openings are closed with a soft rubber ball.

If pumping does not remove any water from a compartment, the tube running from the bilge pump opening to the bottom of the compartment may be damaged or loose. If this is the case, there could be a significant amount of water in the compartment, but the pump is unable to pull it up. [Figure 4-3] Be sure to replace the plugs firmly in each bilge pump opening.

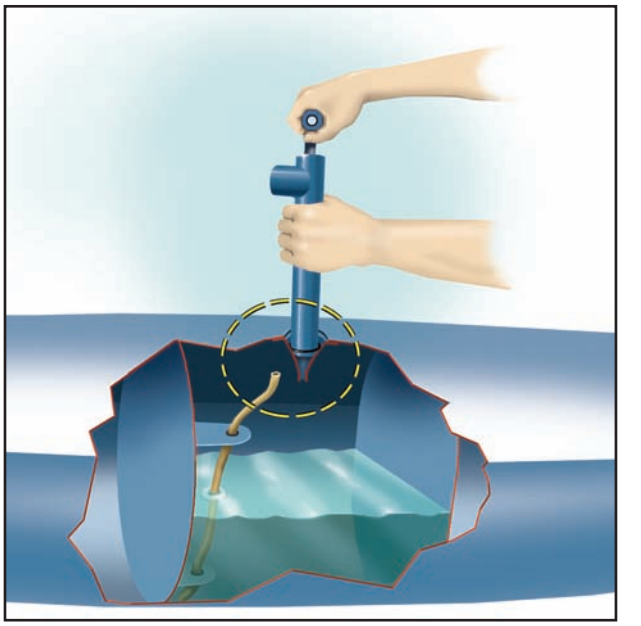


Figure 4-3. Be suspicious if pumping does not remove a small amount of water. If the bilge pump tube is damaged, there may be water in the compartment that the pump cannot remove.

At the stern of the float, check the aft bulkhead, or transom. This area is susceptible to damage from the water rudder moving beyond its normal range of travel. Carefully check the skin for any pinholes or signs of damage from contact with the water rudder or hinge hardware. Inspect the water rudder retraction and steering mechanism and look over the water rudder for any damage. Remove any water weeds or other debris lodged in the water rudder assembly. Check the water rudder cables that run from the float to the fuselage. [Figure 4-4]

Figure 4-4. Inspect the water rudders, cables, springs, and pulleys for proper operation.

To check the empennage area, untie the seaplane, gently push it away from the dock, and turn it 90° so the tail extends over the dock. Take care not to let the water rudders contact the dock. In addition to the normal empennage inspection, check the cables that connect the water rudders to the air rudder. With the air rudder centered, look at the back of the floats to see that the water rudders are also centered. (On some systems, retracting the water rudders disengages them from the air rudder.) If the seaplane has a ventral fin to improve directional stability, this is the time to check it. Spray frequently douses the rear portion of the seaplane, so be particularly alert for signs of corrosion in this area.

With the empennage inspection complete, continue turning the seaplane to bring the other float against the dock, and tie it to the dock. Inspect the fuselage, wing, and float on this side. If the seaplane has a door on only one side, turn the seaplane so the door is adjacent to the dock when the inspection is complete.

When air temperatures drop toward freezing, ice becomes a matter for concern. Inspect the float compartments and water rudders for ice, and consider the possibility of airframe icing during takeoff due to freezing spray. Water expands as it freezes, and this expansion can cause serious damage to floats. A large amount of water expanding inside a float could cause seams to burst, but even a tiny amount of water freezing and expanding inside a seam can cause severe leakage problems. Many operators who remove their floats for the winter store them upside down with the compartment covers off to allow thorough drainage. When the time comes to reinstall the floats, it's a good idea to look for any bugs or small animals that might have made a home in the floats.

STARTING THE ENGINE

Compared to a landplane, a seaplane's starting procedures are somewhat different. Before starting the engine, the seaplane usually needs to be pushed away from the dock, and quite often, it is the pilot who pushes off. Therefore, the pilot should perform as many of the items on the starting checklist as possible prior to shoving off. This includes briefing passengers and seeing that they have fastened their seatbelts. The passenger briefing should include procedures for evacuation, the use of flotation gear, and the location and operation of regular and emergency exits. All passengers are required to be familiar with the operation of seatbelts and shoulder harnesses (if installed). When the engine is primed and ready to start, the pilot leaves the cockpit, shoves off, returns to the pilot's seat, quickly turns on the master switch and magnetos, verifies that the propeller area is clear, and starts the engine. With oil pressure checked, idle r.p.m. set, and the seaplane taxiing in the desired direction, the pilot then fastens the seatbelt and shoulder harness, secures the door, and continues preparing for takeoff.

When a qualified person is available to help launch the seaplane, the pilot can strap in, close the door, and start the engine while the helper holds the seaplane. In most situations, the helper should position the seaplane so it is facing outward, perpendicular to the dock. It is very important that the helper have experience in the proper handling of seaplanes, otherwise an innocent mistake could cause serious damage to the seaplane or to nearby boats, structures, or other seaplanes.

TAXIING AND SAILING

One major difference between taxiing a landplane and taxiing a seaplane is that the seaplane is virtually always in motion, and there are no brakes. When idling, a landplane usually remains motionless, and when moving, brakes can be used to control its speed or bring it to a stop. But once untied, the seaplane floats freely along the water surface and constantly moves due to the forces of wind, water currents, propeller thrust, and inertia. It is important that the seaplane pilot be familiar with the existing wind and water conditions, plan an effective course of action, and mentally stay ahead of the seaplane.

There are three basic positions or attitudes used in moving a seaplane on the water, differentiated by the position of the floats and the speed of the seaplane through the water. They are the idling or displacement position, the plowing position, and the planing or step position.

IDLING POSITION

In the **idling position** or **displacement position**, the buoyancy of the floats supports the entire weight of the seaplane and it remains in an attitude similar to being at rest on the water. Engine r.p.m. is kept as low as possible to control speed, to keep the engine from overheating, and to minimize spray. In almost all circumstances, the elevator control should be held all the way back to keep the nose as high as possible and minimize spray damage to the propeller. This also improves maneuverability by keeping more of the water rudder underwater. The exception is when a strong tailwind component or heavy swells could allow the wind to lift the tail and possibly flip the seaplane over. In such conditions, hold the elevator control forward enough to keep the tail down. [Figure 4-5 on next page]

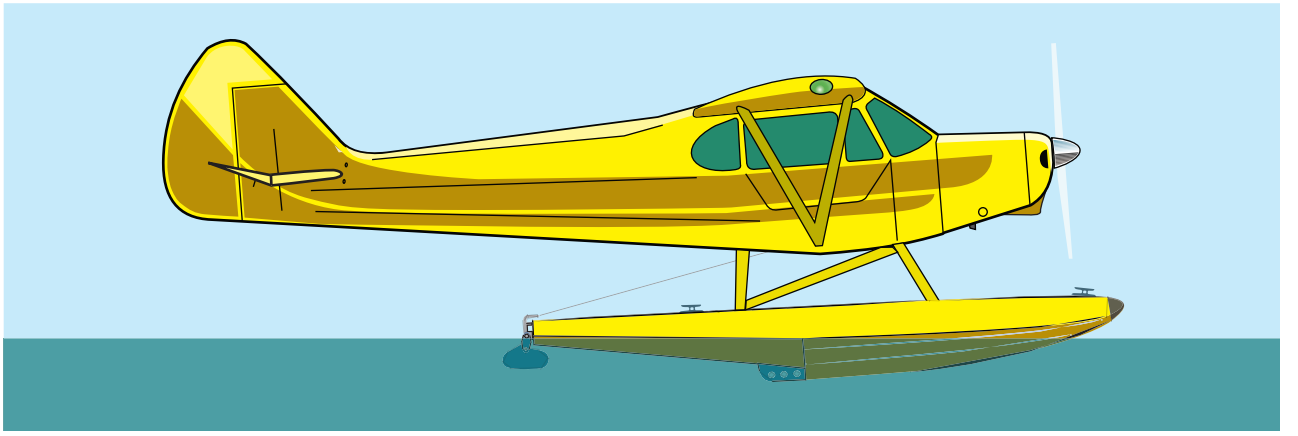


Figure 4-5. Idling position. The engine is at idle r.p.m., the seaplane moves slowly, the attitude is nearly level, and buoyancy supports the seaplane.

Use the idling or displacement position for most taxiing operations, and keep speeds below 6-7 knots to minimize spray getting to the propeller. It is especially important to taxi at low speed in congested or confined areas because inertia forces at higher speeds allow the seaplane to coast farther and serious damage can result from even minor collisions. Cross boat wakes or swells at a 45° angle, if possible, to minimize pitching or rolling and the possibility of an upset.

PLOWING POSITION

Applying power causes the center of buoyancy to shift back, due to increased hydrodynamic pressure on the bottoms of the floats. This places more of the seaplane's weight behind the step, and because the floats are narrower toward the rear, the sterns sink farther into the water. Holding the elevator full up also helps push the tail down due to the increased airflow from the propeller. The **plowing position** creates high drag, requiring a relatively large amount of power for a modest gain in speed. Because of the higher r.p.m., the propeller may pick up spray even though the nose is high. The higher engine power combined with low cooling airflow creates a danger of heat buildup in the engine. Monitor engine temperature carefully to avoid overheating. Taxiing in the plowing position is not recommended. It is usually just the transitional phase between idle taxi and planing. [Figure 4-6]

PLANING OR STEP POSITION

In the **planing position**, most of the seaplane's weight is supported by hydrodynamic lift rather than the buoyancy of the floats. (Because of the wing's speed through the air, aerodynamic lift may also be supporting some of the weight of the seaplane.) Hydrodynamic lift depends on movement through the water, like a water ski. As the float moves faster through the water, it becomes possible to change the pitch attitude to raise the rear portions of the floats clear of the water. This greatly reduces water drag, allowing the seaplane to accelerate to lift-off speed. This position is most often called **on the step**. [Figure 4-7]

There is one pitch attitude that produces the minimum amount of drag when the seaplane is on the step. An experienced seaplane pilot can easily find this "sweet spot" or "slick spot" by the feel of the floats on the water, but the beginning seaplane pilot usually needs to rely on gauging the position of the nose on the horizon. If the nose is considerably high, the rear portions of the floats contact the water, drag increases, and the

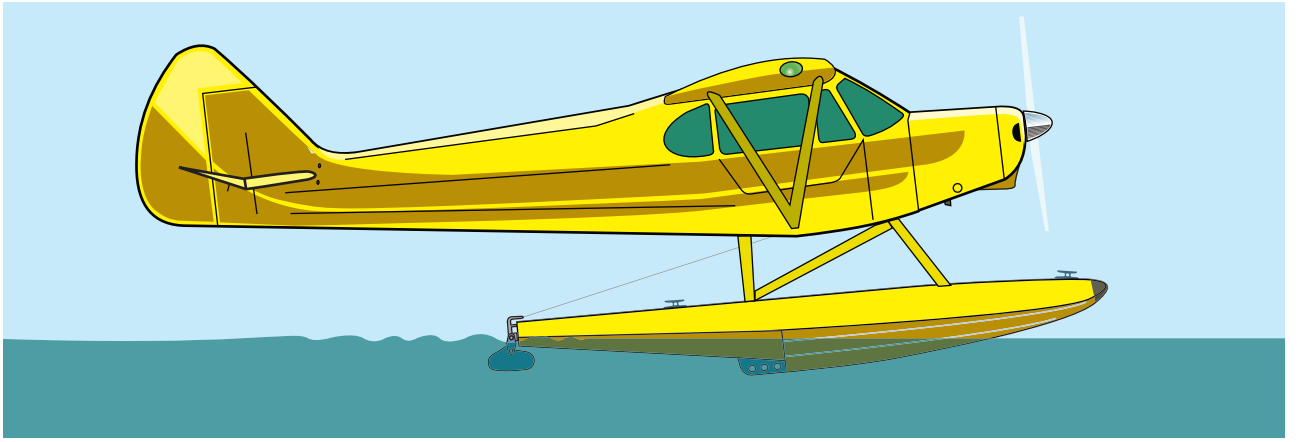


Figure 4-6. Plowing position.

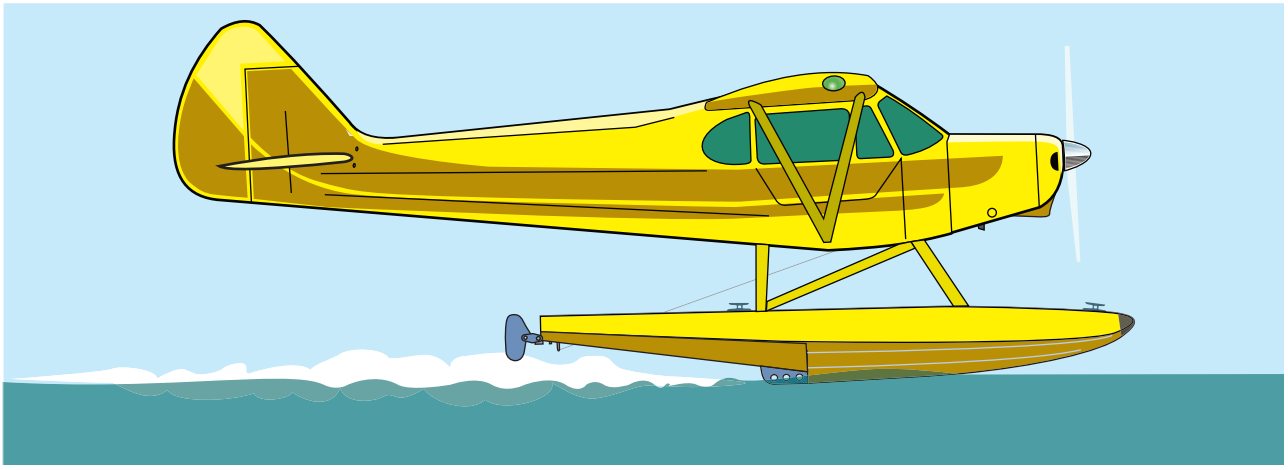


Figure 4-7. On the step. The attitude is nearly level, and the weight of the seaplane is supported mostly by hydrodynamic lift. Behind the step, the floats are essentially clear of the water.

seaplane tends to start settling back into more of a plowing position. If the nose is held only slightly higher than the ideal planing attitude, the seaplane may remain on the step but take much longer to accelerate to rotation speed. On the other hand, if the nose is too low, more of the front portion of the float contacts the water, creating more drag. This condition is called dragging, and as the nose pulls down and the seaplane begins to slow, it can sometimes feel similar to applying the brakes in a landplane.

To continue to taxi on the step instead of taking off, reduce the power as the seaplane is eased over onto the step. More power is required to taxi with a heavy load. However, 65 to 70 percent of maximum power is a good starting point.

Taxiing on the step is a useful technique for covering long distances on the water. Carefully reducing power as the seaplane comes onto the step stops acceleration so that the seaplane maintains a high speed across the water, but remains well below flying speed. At these speeds, the water rudders must be retracted to prevent damage, but there is plenty of airflow for the air rudder. With the seaplane on the step, gentle turns can be made by using the air rudder and the ailerons, always maintaining a precise planing attitude with elevator. The ailerons are positioned into the turn, except when aileron into the wind is needed to keep the upwind wing from lifting.

Step taxiing should only be attempted in areas where the pilot is confident there is sufficient water depth, no floating debris, no hidden obstructions, and no other water traffic nearby. It can be difficult to spot floating hazards at high speeds, and an encounter with a floating log or other obstruction could tear open a float. Your seaplane is not as maneuverable as craft that were designed for the water, so avoiding other vessels is much more difficult. Besides the obvious danger of collision, other water traffic creates dangerous wakes, which are a much more frequent cause of damage. If you see that you are going to cross a wake, reduce power to idle and idle taxi across it, preferably at an angle. Never try to step taxi in shallow water. If the floats touch bottom at high speed, the sudden drag is likely to flip the seaplane.

From either the plowing or the step position, when power is reduced to idle, the seaplane decelerates quite rapidly and eventually assumes the displacement or idle position. Be careful to use proper flight control pressures during the deceleration phase because as weight is transferred toward the front of the floats and drag increases, some seaplanes have a tendency to nose over. Control this with proper use of the elevator.

TURNS

At low speeds and in light winds, make turns using the water rudders, which move in conjunction with the air rudder. As with a landplane, the ailerons should be positioned to minimize the possibility of the wind lifting a wing. In most airplanes, left turns are somewhat easier and can be made tighter than right turns because of torque. If water rudders have the proper amount of movement, most seaplanes can be turned within a radius less than the span of the wing in calm conditions or a light breeze. Water rudders are usually more effective at slow speeds because they are acting in comparatively undisturbed water. At higher speeds, the stern of the float churns the adjacent water, causing the water rudder to become less effective. The dynamic pressure of the water at high speeds may tend to force the water rudders to swing up or retract, and the pounding can cause damage. For these reasons, water rudders should be retracted whenever the seaplane is moving at high speed.

The weathervaning tendency is more evident in seaplanes, and the taxiing seaplane pilot must be constantly aware of the wind's effect on the ability to maneuver. In stronger winds, weathervaning forces may make it difficult to turn

downwind. Often a short burst of power provides sufficient air over the rudder to overcome weathervaning. Since the elevator is held all the way up, the airflow also forces the tail down, making the water rudders more effective. Short bursts of power are preferable to a longer, continuous power application. With continuous power, the seaplane accelerates, increasing the turn radius. The churning of the water in the wake of the floats also makes the water rudders less effective. At the same time, low cooling airflow may cause the engine to heat up.

During a high speed taxiing turn, centrifugal force tends to tip the seaplane toward the outside of the turn. When turning from an upwind heading to a downwind heading, the wind force acts in opposition to centrifugal force, helping stabilize the seaplane. On the other hand, when turning from downwind to upwind, the wind force against the fuselage and the underside of the wing increases the tendency for the seaplane to lean to the outside of the turn, forcing the downwind float deeper into the water. In a tight turn or in strong winds, the combination of these two forces may be sufficient to tip the seaplane to the extent that the downwind float submerges or the outside wing drags in the water, and may even flip the seaplane onto its back. The further the seaplane tips, the greater the effect of the crosswind, as the wing presents more vertical area to the wind force. [Figure 4-8]

When making a turn into the wind from a crosswind condition, often all that is necessary to complete the turn is to neutralize the air rudder and allow the seaplane to weathervane into the wind. If taxiing directly downwind, use the air rudder momentarily to get the turn started, then let the wind complete the turn. Sometimes opposite rudder may be needed to control the rate of turn.

Stronger winds may make turns from upwind to downwind more difficult. The plow turn is one technique for turning downwind when other methods are inadequate, but this maneuver is only effective in certain seaplanes. It takes advantage of the same factor that reduces a floatplane's yaw stability in flight: the large vertical area of the floats forward of the center of gravity. In the plowing attitude, the front portion of each float comes out of the water, presenting a large vertical surface for the wind to act upon. This tends to neutralize the weathervaning force, allowing the turn to proceed. At the same time, the center of buoyancy shifts back. Since this is the axis around which the seaplane pivots while

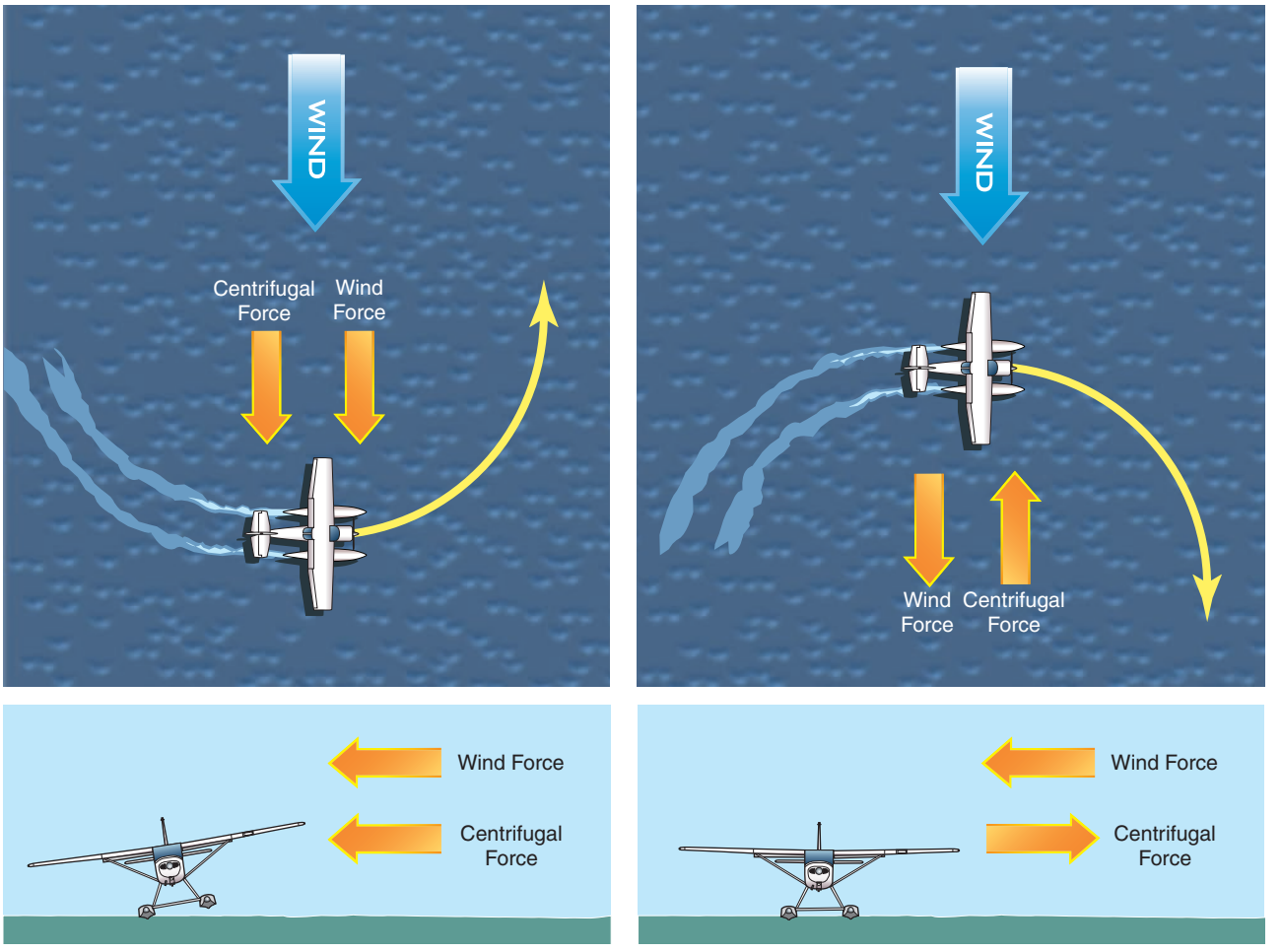


Figure 4-8. Wind effects in turns. When the wind and centrifugal force act in the same direction, the downwind float can be forced underwater. When the wind is countered by centrifugal force, the seaplane is more stable.

on the water, more of the fuselage is now forward of the axis and less is behind, further decreasing the weathervaning tendency. In some seaplanes, this change is so pronounced in the plowing attitude that they experience reverse weathervaning, and tend to turn downwind rather than into the wind. Experienced seaplane pilots can sometimes use the throttle as a turning device in high wind conditions by increasing power to cause a nose-up position when turning downwind, and decreasing power to allow the seaplane to weathervane into the wind. [Figure 4-9]

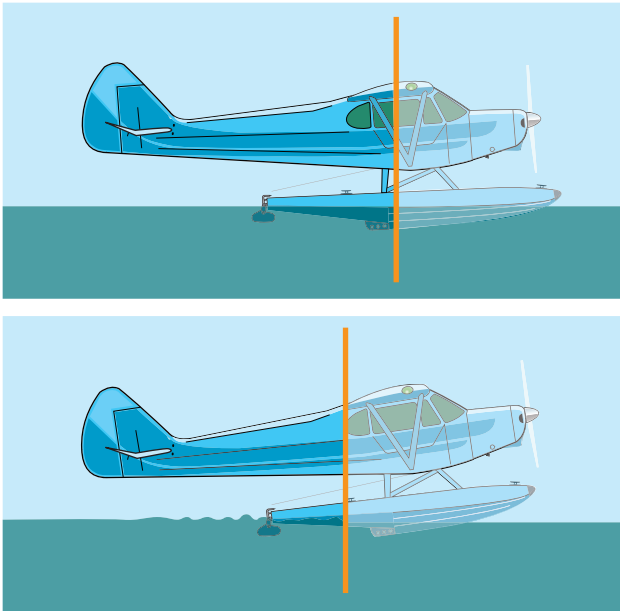


Figure 4-9. In the plowing position, the exposed area at the front of the floats, combined with the rearward shift of the center of buoyancy, can help to counteract the weathervaning tendency.

To execute a plow turn, begin with a turn to the right, then use the weathervaning force combined with full left rudder to turn back to the left. As the seaplane passes its original upwind heading, add enough power to place it into the plow position, continuing the turn with the rudder. As the seaplane comes to the downwind heading, reduce power and return to an idle taxi. From above, the path of the turn looks like a question mark. [Figure 4-10]

Plow turns are useful only in very limited situations because they expose the pilot to a number of potential dangers. They should not be attempted in rough water or gusty conditions. Floatplanes are least stable when in the plowing attitude, and are very susceptible to capsizing. In spite of the nose-high attitude, the high power setting often results in spray damage to the propeller. In most windy situations, it is much safer to sail the seaplane backward (as explained in the next section) rather than attempt a plow turn.

When the seaplane is on the step, turns involve careful balancing of several competing forces. As the rate of turn increases, the floats are being forced to move somewhat sideways through the water, and they resist this sideways motion with drag, much like an airplane fuselage in a skidding turn. More power is required to overcome this drag and maintain planing speed. This skidding force also tends to roll the seaplane toward the outside of the turn, driving the outside float deeper into the water and adding more drag on that side. To prevent this, use aileron into the turn to keep the outside wing from dropping. Once full aileron into the step turn is applied, any further roll to the outside can only be stopped by reducing the rate of turn, so pay careful attention to the angle of the wings and the feel of the water drag on the floats to catch any indication that the outside float is starting to submerge. When stopping a step turn, always return to a straight path before reducing power.

At step taxi speeds, the centrifugal force in a turn is far greater than at idle taxi speed, so the forces involved in turning from downwind to upwind are proportionately more dangerous, especially in strong winds. Chances are, by the time a pilot discovers that the outside float is going under, the accident is almost inevitable. However, immediate full rudder out of the turn and power reduction may save the situation by reversing

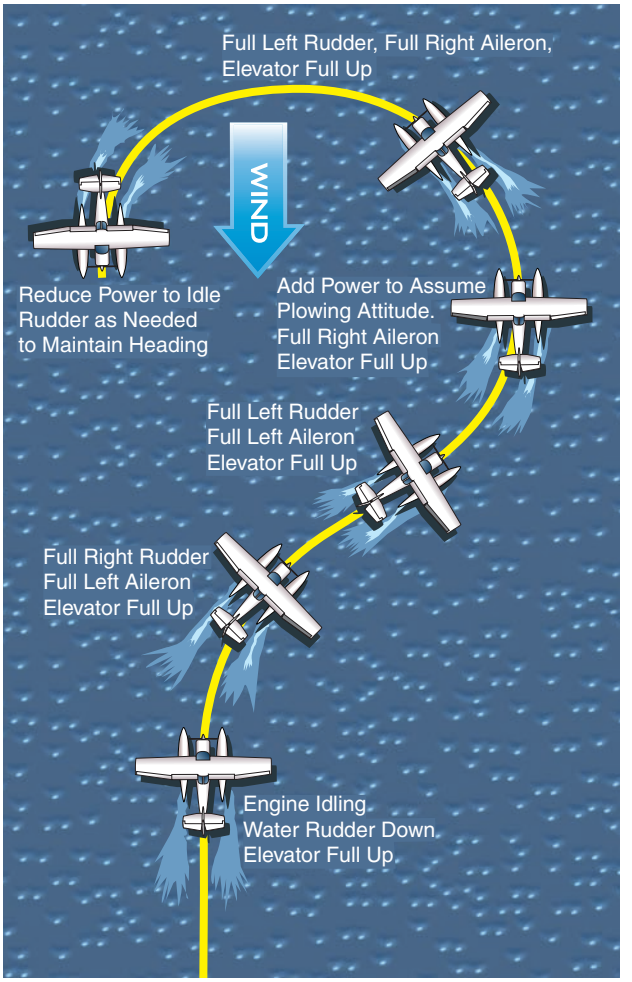


Figure 4-10. Plow turn from upwind to downwind.

the centrifugal force and allowing the buried float to come up.

SAILING

Landplane pilots are accustomed to taxiing by pointing the nose of the airplane in the desired direction and rolling forward. In seaplane operations, there are often occasions when it is easier and safer to move the seaplane backward or to one side because wind, water conditions, or limited space make it impractical to attempt a turn. If there is a significant wind, a seaplane can be guided into a space that might seem extremely cramped to an inexperienced pilot. **Sailing** is a method of guiding the seaplane on the water using the wind as the main motive force. It is a useful technique for maneuvering in situations where conventional taxiing is undesirable or impossible. Since the seaplane automatically aligns itself so the nose points into the wind, sailing in a seaplane usually means moving backward.

In light wind conditions with the engine idling or off, a seaplane naturally weathervanes into the wind. If the pilot uses the air rudder to swing the tail a few degrees, the seaplane sails backward in the direction the tail is pointed. This is due to the keel effect of the floats, which tends to push the seaplane in the direction the sterns of the floats are pointing. In this situation, lift the water rudders, since their action is counter to what is desired. When sailing like this, the sterns of the floats have become the front, as far as the water is concerned, but the rear portions of the floats are smaller and therefore not as buoyant. If the wind is strong and speed starts to build up, the sterns of the floats could start to submerge and dig into the water. Combined with the lifting force of the wind over the wings, the seaplane could conceivably flip over backward, so use full forward elevator to keep the sterns of the floats up and the seaplane's nose down. Adding power can also help keep the floats from submerging.

If enough engine power is used to exactly cancel the backward motion caused by the wind, the seaplane is not moving relative to the water, so keel effect disappears. However, turning the fuselage a few degrees left or right provides a surface for the wind to push against, so the wind will drive the seaplane sideways in the direction the nose is pointed. Combining these techniques, a skilled pilot can sail a seaplane around obstacles and into confined docking spaces. [Figure 4-11]

Figure 4-12 shows how to position the controls for the desired direction of motion in light or strong winds. With the engine off, lowering the wing flaps and opening the cabin doors increases the air resistance and thus adds to the effect of the wind. This increases sailing speed but may reduce the effect of the air rudder. If sailing with the engine off results in too much motion downwind, but an idling engine produces too much thrust, adding carburetor heat or turning off one magneto can reduce the engine power slightly. Avoid using carburetor heat or running on one magneto for extended periods. Instead, start the engine briefly to slow down.

Where currents are a factor, such as in strong tidal flows or a fast flowing river, sailing techniques must

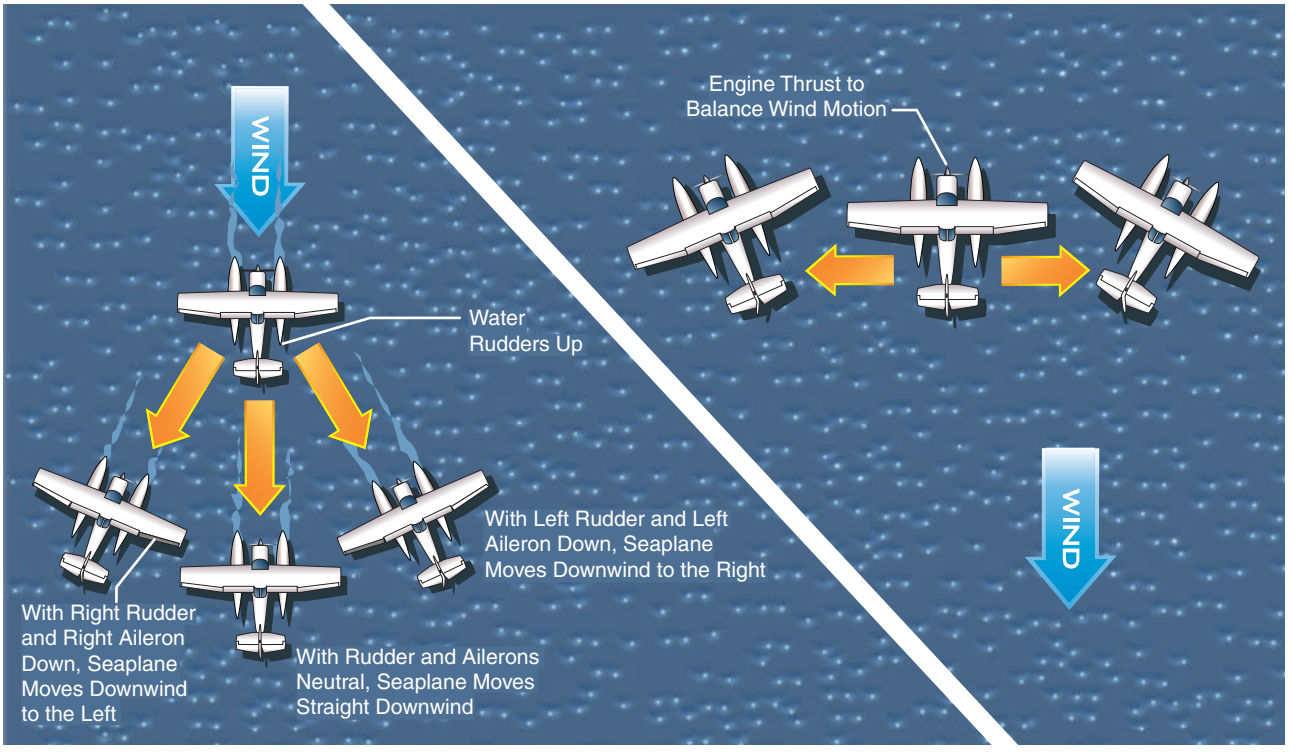

WIND
Engine Thrust to Balance Wind Motion
Water Rudders Up
With Left Rudder and Left Aileron Down, Seaplane Moves Downwind to the Right
WIND
With Right Rudder and Right Aileron Down, Seaplane Moves Downwind to the Left
With Rudder and Ailerons Neutral, Seaplane Moves Straight Downwind

Figure 4-11. When the seaplane moves through the water, keel effect drives it in the direction the tail is pointed. With no motion through the water, the wind pressure on the fuselage pushes the seaplane toward the side the nose is pointed.

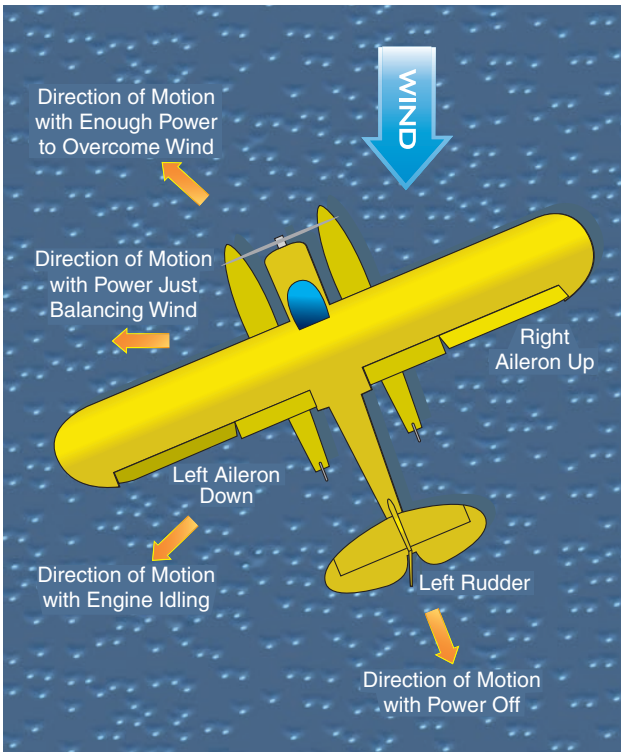

WIND
Direction of Motion with Enough Power to Overcome Wind
Direction of Motion with Power Just Balancing Wind
Right Aileron Up
Left Aileron Down
Direction of Motion with Engine Idling
Left Rudder
Direction of Motion with Power Off

Figure 4-12. By balancing wind force and engine thrust, it is possible to sail sideways or diagonally forward. Of course, reversing the control positions from those illustrated permits the pilot to sail to the opposite side.

incorporate the movement of the water along with the wind. The current may be a help or a hindrance, or change from a help to a hindrance when the pilot attempts to change direction. The keel effect only works when the floats are moving through the water. If the current is moving the seaplane, there may be little or no motion relative to the water, even though the seaplane is moving relative to the shore. Using wind, current, and thrust to track the desired course requires careful planning and a thorough understanding of the various forces at work.

With the engine shut down, most flying boats sail backward and toward whichever side the nose is pointed, regardless of wind velocity, because the hull does not provide as much keel effect as floats in proportion to the side area of the seaplane above the waterline. To sail directly backward in a flying boat, release the controls and let the wind steer. Sailing is an essential part of seaplane operation. Since each type of seaplane has its own peculiarities, practice sailing until thoroughly familiar with that particular type. Practice in large bodies of water such as lakes or bays, but sufficiently close to a prominent object in order to evaluate performance.

Before taxiing into a confined area, carefully evaluate the effects of the wind and current, otherwise the seaplane may be driven into obstructions. With a seaplane of average size and power at idle, a water current of 5 knots can offset a wind velocity of 25 knots in the opposite direction. This means that a 5 knot current will carry the seaplane against a 25 knot wind. Differential power can be used to aid steering in multiengine seaplanes.

PORPOISING

Porpoising is a rhythmic pitching motion caused by dynamic instability in forces along the float bottoms while on the step. An incorrect planing attitude sets off a cyclic oscillation that steadily increases in amplitude unless the proper pitch attitude is reestablished. [Figure 4-13]

A seaplane travels smoothly across the water on the step only if the floats or hull remain within a moderately tolerant range of pitch angles. If the nose is held too low during planing, water pressure in the form of a small crest or wall builds up under the bows of the floats. Eventually, the crest becomes large enough that the fronts of the floats ride up over the crest, pitching the bows upward. As the step passes over the crest, the floats tip forward abruptly, digging the bows a little deeper into the water. This builds a new crest in front of the floats, resulting in another oscillation. Each oscillation becomes increasingly severe, and if not corrected, will cause the seaplane to nose into the water, resulting in extensive damage or possible capsizing. A second type of porpoising can occur if the nose is held too high while on the step. Porpoising can also cause a premature lift-off with an extremely high angle of attack, which can result in a stall and a subsequent nose-down drop into the water. Porpoising occurs during the takeoff run if the planing angle is not properly controlled with elevator pressure just after passing through the “hump” speed. The pitching created when the seaplane encounters a swell system while on the step can also initiate porpoising. Usually, porpoising does not start until the seaplane has passed a degree or two beyond the acceptable planing angle range, and

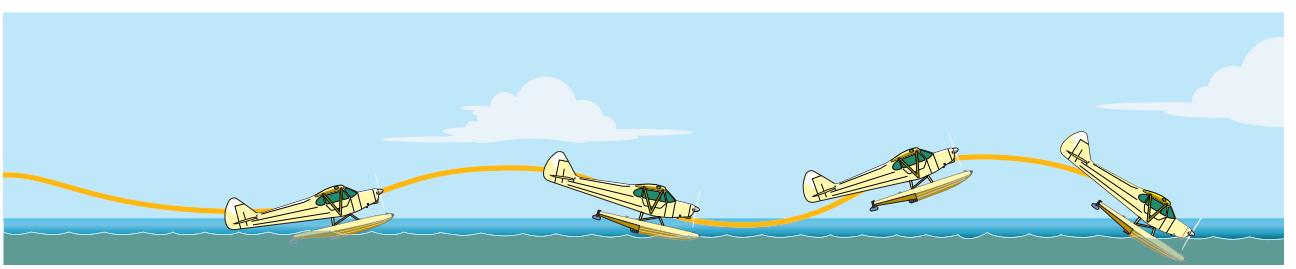


Figure 4-13. Porpoising increases in amplitude if not corrected promptly.

does not cease until after the seaplane has passed out of the critical range by a degree or two.

If porpoising occurs due to a nose-low planing attitude, stop it by applying timely back pressure on the elevator control to prevent the bows of the floats from digging into the water. The back pressure must be applied and maintained until porpoising stops. If porpoising does not stop by the time the second oscillation occurs, reduce the power to idle and hold the elevator control back firmly so the seaplane settles onto the water with no further instability. Never try to "chase" the oscillations, as this usually makes them worse and results in an accident.

Pilots must learn and practice the correct pitch attitudes for takeoff, planing, and landing for each type of seaplane until there is no doubt as to the proper angles for the various maneuvers. The upper and lower limits of these pitch angles are established by the design of the seaplane; however, changing the seaplane's gross weight, wing flap position, or center of gravity location also changes these limits. Increased weight increases the displacement of the floats or hull and raises the lower limit considerably. Extending the wing flaps frequently trims the seaplane to the lower limit at lower speeds, and may lower the upper limit at high speeds. A forward center of gravity increases the possibility of high angle porpoising, especially during landing.

SKIPPING

Skipping is a form of instability that may occur when landing at excessive speed with the nose at too high a pitch angle. This nose-up attitude places the seaplane at the upper trim limit of stability and causes the seaplane to enter a cyclic oscillation when touching the water, which results in the seaplane skipping across the surface. This action is similar to skipping flat stones across the water. Skipping can also occur by crossing a boat wake while taxiing on the step or during a takeoff. Sometimes the new seaplane pilot confuses a skip with a porpoise, but the pilot's body sensations can quickly distinguish between the two. A skip gives the body vertical "G" forces, similar to bouncing a landplane. Porpoising is a rocking chair type forward and aft motion feeling.

To correct for skipping, first increase back pressure on the elevator control and add sufficient power to prevent the floats from contacting the water. Then establish the proper pitch attitude and reduce the power gradually to allow the seaplane to settle gently onto the water. Skipping oscillations do not tend to increase in amplitude, as in porpoising, but they do subject the floats and airframe to unnecessary pounding and can lead to porpoising.

TAKEOFFS

A seaplane takeoff may be divided into four distinct phases: (1) The displacement phase, (2) the hump or plowing phase, (3) the planing or on the step phase, and (4) the lift-off.

The displacement phase should be familiar from the taxiing discussion. During idle taxi, the displacement of water supports nearly all of the seaplane's weight. The weight of the seaplane forces the floats down into the water until a volume that weighs exactly as much as the seaplane has been displaced. The surface area of the float below the waterline is called the wetted area, and it varies depending on the seaplane's weight. An empty seaplane has less wetted area than when it is fully loaded. Wetted area is a major factor in the creation of drag as the seaplane moves through the water.

As power is applied, the floats move faster through the water. The water resists this motion, creating drag. The forward portion of the float is shaped to transform the horizontal movement through the water into an upward lifting force by diverting the water downward. Newton's Third Law of Motion states that for every action, there is an equal and opposite reaction, and in this case, pushing water downward results in an upward force known as hydrodynamic lift.

In the plowing phase, hydrodynamic lift begins pushing up the front of the floats, raising the seaplane's nose and moving the center of buoyancy aft. This, combined with the downward pressure on the tail generated by holding the elevator control all the way back, forces the rear part of the floats deeper into the water. This creates more wetted area and consequently more drag, and explains why the seaplane accelerates so slowly during this part of the takeoff.

This resistance typically reaches its peak just before the floats are placed into a planing attitude. Figure 4-14 shows a graph of the drag forces at work during a seaplane takeoff run. The area of greatest resistance is referred to as the hump because of the shape of the water drag curve. During the plowing phase, the increasing water speed generates more and more hydrodynamic lift. With more of the weight supported by hydrodynamic lift, proportionately less is supported by displacement and the floats are able to rise in the water. As they do, there is less wetted area to cause drag, which allows more acceleration, which in turn increases hydrodynamic lift. There is a limit to how far this cycle can go, however, because as speed builds, so does the amount of drag on the remaining wetted area. Drag increases as the square of speed, and eventually drag forces would balance the power output of the engine and the seaplane would continue along the surface without further acceleration.

Seaplanes have been built with sufficient power to accelerate to takeoff speed this way, but fortunately the step was invented, and it makes further acceleration possible without additional power. After passing over the hump, the seaplane is traveling fast enough that its weight can be supported entirely by hydrodynamic lift. Relaxing the back pressure on the elevator control allows the float to rock up onto the step, and lifts the

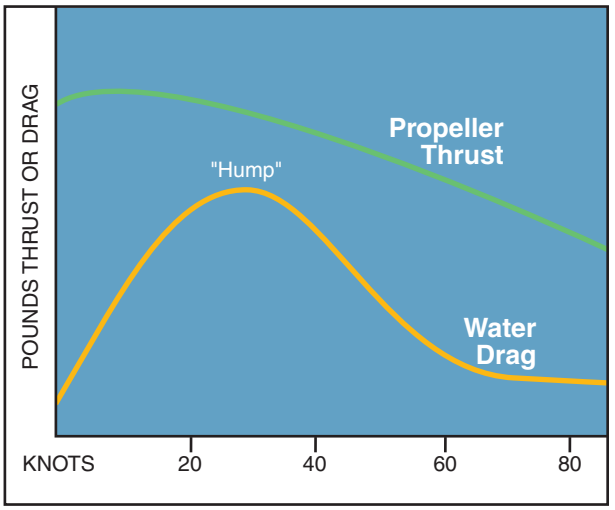


Figure 4-14. This graph shows water drag and propeller thrust during a takeoff run.

rear portions of the floats clear of the water. This eliminates all of the wetted area aft of the step, along with the associated drag.

As further acceleration takes place, the flight controls become more responsive, just as in a landplane. Elevator deflection is gradually reduced to hold the required planing attitude. As the seaplane continues to accelerate, more and more weight is being supported by the aerodynamic lift of the wings and water resistance continues to decrease. When all of the weight is transferred to the wings, the seaplane becomes airborne.

Several factors greatly increase the water drag or resistance, such as heavy loading of the seaplane or glassy water conditions. In extreme cases, the drag may exceed the available thrust and prevent the seaplane from becoming airborne. This is particularly true when operating in areas with high density altitudes (high elevations/high temperatures) where the engine cannot develop full rated power. For this reason the pilot should practice takeoffs using only partial power to simulate the longer takeoff runs needed when operating where the density altitude is high and/or the seaplane is heavily loaded. This practice should be conducted under the supervision of an experienced seaplane instructor, and in accordance with any cautions or limitations in the AFM/POH. Plan for the additional takeoff area required, as well as the flatter angle of climb after takeoff, and allow plenty of room for error.

Use all of the available cues to verify the wind direction. Besides reading the water, pick up clues to the wind's direction from wind indicators and streamers on the masts of moored boats, flags on flagpoles, or rising smoke. A boat moored to a buoy points into the wind, but be aware that it may have a stern anchor as well, preventing it from pointing into the wind. Waterfowl almost always align themselves facing into the wind.

Naturally, be sure you have enough room for takeoff. The landing distance of a seaplane is much shorter than that required for takeoff, and many pilots have landed in areas that have turned out to be too short for takeoff. If you suspect that the available distance may be inadequate, consider reducing weight by leaving some of your load behind or wait for more favorable weather conditions. A takeoff that would be dangerous on a hot, still afternoon might be accomplished safely on the following morning, with cooler temperatures and a brisk wind.

In addition to wind, consider the effects of the current when choosing the direction for takeoff. Keep in mind that when taxiing in the same direction as the current, directional control may be reduced because the seaplane is not moving as quickly through the water. In rivers or tidal flows, make crosswind or calm wind takeoffs in the same direction as the current. This reduces the water forces on the floats. Suppose the seaplane lifts off at 50 knots and the current is 3 knots. If winds are calm, the seaplane needs a water speed of 47 knots to take off downstream, but must accelerate to a water speed of 53 knots to become airborne against the current. This difference of 6 knots requires a longer time on the water and generates more stress on the floats. The situation becomes more complex when wind is a factor. If the wind is blowing against the current, its speed can help the wings develop lift sooner, but will raise higher waves on the surface. If the wind is in the same direction as the current, at what point does the speed of the wind make it more worthwhile to take off against the current? In the previous example, a wind velocity of 3 knots would exactly cancel the benefit of the current, since the air and water would be moving at the same speed. In most situations, take off into the wind if the speed of the wind is greater than the current.

Unlike landplane operations at airports, many other activities are permitted in waters where seaplane operations are conducted. Seaplane pilots encounter a variety of objects on the water, some of which are nearly submerged and difficult to see. These include items that are stationary, such as pilings and buoys, and those that are mobile, like logs, swimmers, water skiers, and a variety of watercraft. Before beginning the takeoff, it is a good practice to taxi along the intended takeoff path to check for any hazardous objects or obstructions.

Make absolutely sure the takeoff path ahead is free of boats, swimmers, and other water traffic, and be sure it will remain so for the duration of the takeoff run. Powerboats, wind-surfers, and jet-skis can move quickly and change direction abruptly. As the

seaplane's nose comes up with the application of full power, the view ahead may be completely blocked by the cowling. Check to the sides and behind the seaplane as well as straight ahead, since many watercraft move much faster than the normal taxi speed and may be passing the seaplane from behind. In addition to the vessels themselves, also scan for their wakes and try to anticipate where the wakes will be during takeoff. Operators of motorboats and other watercraft often do not realize the hazard caused by moving their vessels across the takeoff path of a seaplane. It is usually better to delay takeoff and wait for the swells to pass rather than encountering them at high speed. Even small swells can cause dangerous pitching or rolling for a seaplane, so taxi across them at an angle rather than head-on. Remember to check for other air traffic and make any appropriate radio calls.

Be sure to use the pre-takeoff checklist on every takeoff. All checks are performed as the seaplane taxies, including the engine runup. Hold the elevator control all the way back throughout the runup to minimize spray around the propeller. If there is significant wind, let the seaplane turn into the wind for the runup. As r.p.m. increases, the nose rises into the plowing position and the seaplane begins to accelerate. Since this is a relatively unstable position, performing the runup into the wind minimizes the possibility of crosswinds, rough water, or gusts upsetting the seaplane. Waste no time during the runup checks, but be thorough and precise. Taxi speed will drop as soon as the power is reduced.

Water rudders are normally retracted before applying takeoff power. The buffeting and dynamic water pressure during a takeoff can cause serious damage if the water rudders are left down.

As full power is applied during takeoff in most seaplanes, torque and P-factor tend to force the left float down into the water. Right rudder pressure helps to maintain a straight takeoff path. In some cases, left aileron may also help to counter the tendency to turn left at low speeds, by increasing drag on the right side of the seaplane.

Density altitude is particularly important in seaplane flying. High, hot, and humid conditions reduce engine power and propeller efficiency, and the seaplane must also attain a higher water speed in order to generate the lift required for takeoff. This increase in water speed means overcoming additional water drag. All of these factors combine to increase takeoff distances and decrease climb performance. In high density altitude conditions, consider not only the length of the water run, but the room required for a safe climbout as well.

The land area around a body of water is invariably somewhat higher than the water surface. Tall trees are common along shorelines, and in many areas, steep or mountainous terrain rises from the water's edge. Be certain the departure path allows sufficient room for safe terrain clearance or for a wide climbing turn back over the water.

There are specific takeoff techniques for different wind and water situations. Large water areas almost always allow a takeoff into the wind, but there are occasionally circumstances where a crosswind or downwind takeoff may be more appropriate. Over the years, techniques have evolved for handling rough water or a glassy smooth surface. Knowing and practicing these techniques not only keep skills polished so they are available when needed, they also increase overall proficiency and add to the enjoyment of seaplane flying.

NORMAL TAKEOFFS

Make normal takeoffs into the wind. Once the wind direction is determined and the takeoff path chosen, configure the seaplane and perform all of the pre-takeoff checks while taxiing to the takeoff position. Verify that the takeoff will not interfere with other traffic, either on the water's surface or in the air.

Hold the elevator control all the way back and apply full power smoothly and quickly, maintaining directional control with the rudder. When the nose reaches its highest point, ease the back pressure to allow the seaplane to come up on the step. Establish the optimum planing attitude and allow the seaplane to accelerate to lift-off speed. In most cases, the seaplane lifts off as it reaches flying speed. Occasionally it may be necessary to gently help the floats unstick by either using some aileron to lift one float out of the water or by adding a small amount of back pressure on the elevator control. Once off the water, the seaplane accelerates more quickly. When a safe airspeed is achieved, establish the pitch attitude for the best rate of climb (V_Y) and complete the climb checklist. Turn as necessary to avoid overflying noise-sensitive areas, and reduce power as appropriate to minimize noise.

CROSSWIND TAKEOFFS

In restricted or limited areas such as canals or narrow rivers, it is not always possible to take off or land directly into the wind. Therefore, acquiring skill in crosswind techniques enhances the safety of seaplane operation. Crosswinds present special difficulties for seaplane pilots. The same force that acts to lift the upwind wing also increases weight on the downwind float, forcing it deeper into the water and increasing drag on that side. Keep in mind that the allowable crosswind component for a floatplane may be significantly less than for the equivalent landplane.

A crosswind has the same effect on a seaplane during takeoff as on a landplane, that is, it tends to push the seaplane sideways across the takeoff path, which imposes side loads on the landing gear. In addition, wind pressure on the vertical tail causes the seaplane to try to weathervane into the wind.

At the beginning of the takeoff roll in a landplane, drift and weathervaning tendencies are resisted by the friction of the tires against the runway, usually assisted by nosewheel steering, or in some cases even differential braking. The objective in a crosswind takeoff is the same in landplanes and seaplanes: to counteract drift and minimize the side loads on the landing gear.

The sideways drifting force, acting through the seaplane's center of gravity, is opposed by the resistance of the water against the side area of the floats. This creates a force that tends to tip the seaplane sideways, pushing the downwind float deeper into the water and lifting the upwind wing. The partly submerged float has even more resistance to sideways motion, and the upwind wing displays more vertical surface area to the wind, intensifying the problem. Without intervention by the pilot, this tipping could continue until the seaplane capsizes.

During a takeoff in stiff crosswinds, weathervaning forces can cause an uncontrolled turn to begin. As the turn develops, the addition of centrifugal force acting outward from the turn aggravates the problem. The keels of the floats resist the sideways force, and the upwind wing tends to lift. If strong enough, the combination of the wind and centrifugal force may tip the seaplane to the point where the downwind float submerges and subsequently the wingtip may strike the water. This is known as a waterloop, and the dynamics are similar to a groundloop on land. Although some damage occurs when the wingtip hits the ground during a groundloop, the consequences of plunging a wingtip underwater in a seaplane can be disastrous. In a fully developed waterloop, the seaplane may be severely damaged or may capsize. Despite these dire possibilities, crosswind takeoffs can be accomplished safely by exercising good judgment and proper piloting technique.

Since there are no clear reference lines for directional guidance, such as those on airport runways, it can be difficult to quickly detect side drift on water. Waves may make it appear that the water is moving sideways, but remember that although the wind moves the waves, the water remains nearly stationary. The waves are simply an up-and-down motion of the water surface—the water itself is not moving sideways. To maintain a straight path through the water, pick a spot on the shore as an aim point for the takeoff run. On the other hand, some crosswind techniques involve describing a curved path through the water. Experience will help determine which technique is most appropriate for a given situation.

CONTROLLED WEATHERVANING

In light winds, it is easy to counteract the weathervaning tendency during the early part of the takeoff run by creating an allowance for it from the beginning. Prior to adding takeoff power, use the water rudders to set up a heading somewhat downwind of the aim point. The angle will depend on the speed of the wind—the higher

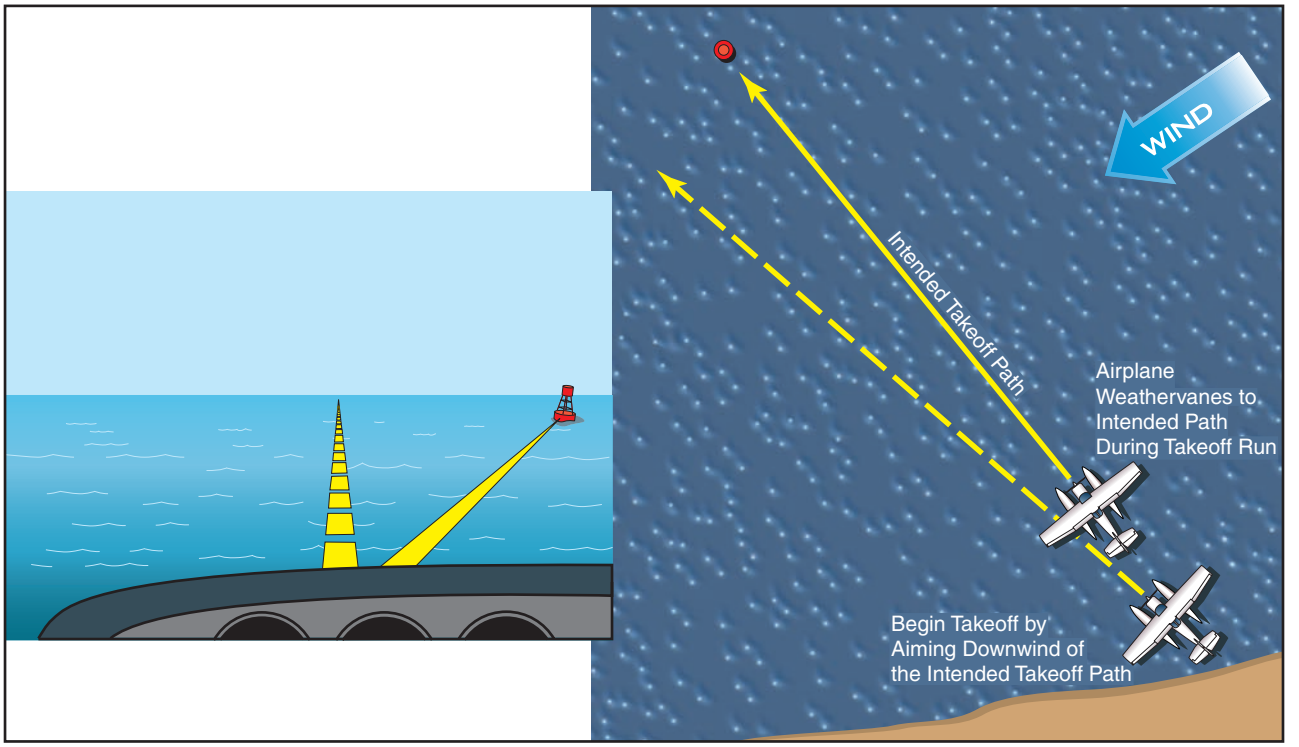


Figure 4-15. Anticipate weathervaning by leading the aim point, setting up a somewhat downwind heading prior to starting the takeoff. Choose an aim point that does not move, such as a buoy or a point on the far shore.

the wind, the greater the lead angle. Create just enough of a lead angle so that when the water rudders are raised and power is applied, the seaplane weathervanes to the desired heading during the time it gains enough speed to make the air rudder and ailerons effective. As the seaplane transitions to the plowing attitude, the weathervaning tendency decreases as the fronts of the floats come out of the water, adding vertical surface area at the front of the seaplane. Use full aileron into the wind as the takeoff run begins, and maintain enough aileron to keep the upwind wing from lifting as airspeed builds. [Figure 4-15 on previous page]

USING WATER RUDDERS

Another technique for maintaining a straight takeoff path involves leaving the water rudders down to assist with steering. Using the water rudders provides added directional control until the aerodynamic controls become effective.

To use this technique, align the seaplane with the aim point on the shore, hold full aileron into the wind, and apply takeoff power. As the seaplane accelerates, use enough aileron pressure to keep the upwind wing down. The downwind float should lift free of the water first. After lift-off, make a coordinated turn to establish the proper crab angle for the climb, and retract the water rudders.

This takeoff technique subjects the water rudders to high dynamic water pressures and could cause damage. Be sure to comply with the advice of the float manufacturer. [Figure 4-16]

DOWNWIND ARC

The other crosswind takeoff technique results in a curved path across the water, starting somewhat into the wind and turning gradually downwind during the takeoff run. This reduces the actual crosswind component at the beginning of the takeoff, when the seaplane is most susceptible to weathervaning. As the aerodynamic controls become more effective, the pilot balances the side loads imposed by the wind with the skidding force of an intentional turn, as always, holding the upwind wing down with the ailerons. [Figure 4-17]

The pilot plans a curved path and follows this arc to produce sufficient centrifugal force so that the seaplane tends to lean outward against the wind force. During the run, the pilot can adjust the rate of turn by varying rudder pressure, thereby increasing or decreasing the centrifugal force to compensate for a changing wind force. In practice, it is quite simple to plan sufficient curvature of the takeoff path to cancel out strong crosswinds, even on very narrow rivers. Note that the tightest part of the downwind arc is when the seaplane is traveling at slower speeds.

The last portion of a crosswind takeoff is somewhat similar to a landplane. Use ailerons to lift the downwind wing, providing a sideways component of lift to counter the effect of the crosswind. This means that the downwind float lifts off first. Be careful not to drop the upwind wing so far that it touches the water. When using a straight takeoff path, keep the nose on the aim point with opposite rudder and maintain the proper step attitude until the other float lifts off. Unlike a landplane, there is usually no advantage in holding the seaplane on the water past normal lift-off speed, and doing so may expose the floats to unnecessary pounding as they splash through the waves. Once airborne, make a coordinated turn to the crab angle that results in a straight track toward the aim point, and pitch to obtain the desired climb airspeed.

Again, experience plays an important part in successful operation during crosswinds. It is essential that all seaplane pilots have thorough knowledge and skill in these maneuvers.

DOWNWIND TAKEOFFS

Downwind takeoffs in a seaplane present a somewhat different set of concerns. If the winds are light, the water is smooth, and there is plenty of room, a downwind takeoff may be more convenient than a long downwind taxi to a position that would allow a takeoff into the wind. In any airplane, the wing needs to attain a specific airspeed in order to fly, and that indicated airspeed is the same regardless of wind direction.

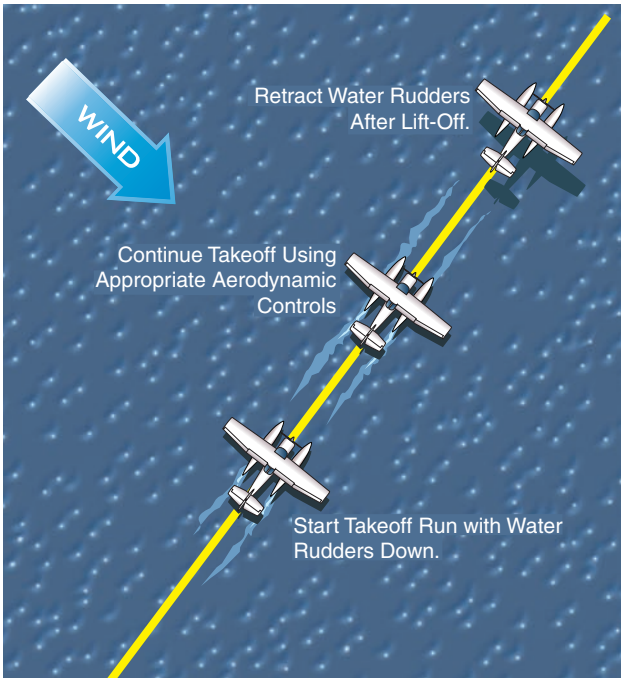

WIND
Retract Water Rudders After Lift-Off.
Continue Takeoff Using Appropriate Aerodynamic Controls
Start Takeoff Run with Water Rudders Down.

Figure 4-16. Remember to retract the water rudders after takeoff to avoid damage during the next landing.

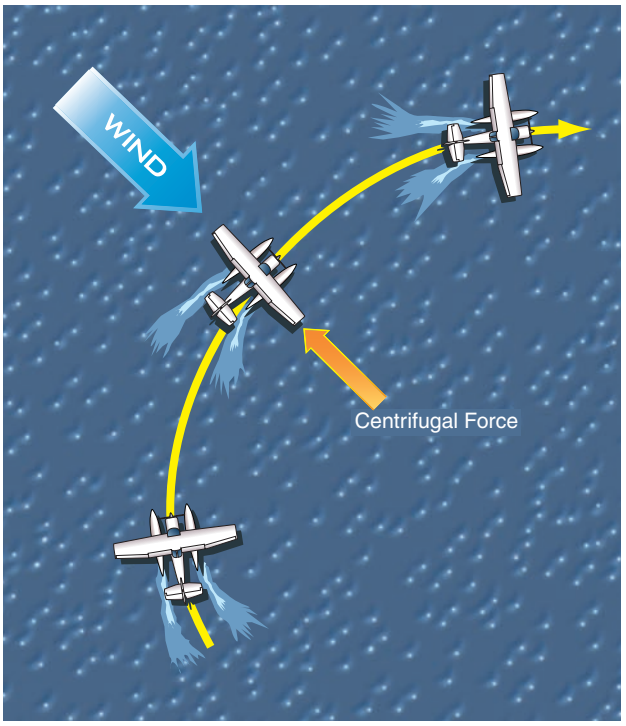


Figure 4-17. The downwind arc balances wind force with centrifugal force.

However, when taking off downwind, obtaining the airspeed means accelerating to a proportionately higher groundspeed. Naturally, the takeoff run is longer because the wings must first be accelerated to the speed of the wind, then accelerated to the correct airspeed to generate the lift required for takeoff. So far, this is identical to what occurs with a landplane during a downwind takeoff. But in addition, a downwind takeoff run in a seaplane is further lengthened by the factor of float drag. The speed of the floats in the water corresponds to the higher groundspeed required in a landplane, but the drag of the floats increases as the square of their speed. This increase in drag is much greater than the increase in rolling resistance of tires and wheel bearings in a landplane. A tailwind may lengthen the seaplane's takeoff distance much more dramatically than the same tailwind in a landplane.

Nevertheless, there are situations in which a downwind takeoff may be more favorable than taking off into the wind. If there is a long lake with mountains at the upwind end and a clear departure path at the other, a downwind takeoff might be warranted. Likewise, noise considerations and thoughtfulness might prompt a downwind takeoff away from a populated shore area if plenty of water area is available. In areas where the current favors a downwind takeoff, the advantage gained from the movement of the water can more than compensate for the wind penalty. Keep in mind that overcoming the current creates far more drag than accelerating a few extra knots downwind with the current. In all cases, safety requires a thorough knowledge of the takeoff performance of the seaplane.

GLASSY WATER TAKEOFFS

Glassy water makes takeoff more difficult in two ways. The smoothness of the surface has the effect of increasing drag, making acceleration and lift-off more difficult. This can feel as if there is suction between the water and the floats. A little surface roughness actually helps break the contact between the floats and the water by introducing turbulence and air bubbles between water and the float bottoms. The intermittent contact between floats and water at the moment of lift-off cuts drag and allows the seaplane to accelerate while still obtaining some hydrodynamic lift, but glassy water maintains a continuous drag force. Once airborne, the lack of visual cues to the seaplane's height above the water can create a potentially dangerous situation unless a positive rate of climb is maintained.

The takeoff technique is identical to a normal takeoff until the seaplane is on the step and nearly at flying speed. At this point, the water drag may prevent the seaplane from accelerating the last few knots to lift-off speed. To reduce float drag and break the grip of the water, the pilot applies enough aileron pressure to lift one float just out of the water and allows the seaplane to continue to accelerate on the step of the other float until lift-off. By allowing the seaplane to turn slightly in the direction the aileron is being held rather than holding opposite rudder to maintain a straight course, considerable aerodynamic drag is eliminated, aiding acceleration and lift-off. When using this technique, be careful not to lift the wing so much that the opposite wing contacts the water. Obviously, this would have serious consequences. Once the seaplane lifts off, establish a positive rate of climb to prevent inadvertently flying back into the water.

Another technique that aids glassy water takeoffs entails roughening the surface a little. By taxiing around in a circle, the wake of the seaplane spreads and reflects from shorelines, creating a slightly rougher surface that can provide some visual depth and help the floats break free during takeoff.

Occasionally a pilot may have difficulty getting the seaplane onto the step during a glassy water takeoff, particularly if the seaplane is loaded to its maximum authorized weight. The floats support additional weight by displacing more water; they sink deeper into the water when at rest. Naturally, this wets more surface area, which equates to increased water drag when the seaplane begins moving, compared to a lightly loaded situation. Under these conditions the seaplane may assume a plowing position when full power is applied, but may not develop sufficient hydrodynamic lift to get on the step due to the additional water drag. The careful seaplane pilot always plans ahead and considers the possibility of aborting the takeoff.

Nonetheless, if these conditions are not too excessive, the takeoff often can be accomplished using the following technique.

After the nose rises to the highest point in the plowing position with full back elevator pressure, decrease back pressure somewhat. The nose will drop if the seaplane has attained enough speed to be on the verge of attaining the step position. After a few seconds, the nose will rise again. At the instant it starts to rise, reinforce the rise by again applying firm back pressure. As soon as the nose reaches its maximum height, repeat the entire routine. After several repetitions, the nose attains greater height and speed increases. If the elevator control is then pushed well forward and held there, the seaplane will slowly flatten out on the step and the controls may then be eased back to the neutral position. Once on the step, the remainder of the takeoff run follows the usual glassy water procedure.

ROUGH WATER TAKEOFFS

The objective in a rough water takeoff is similar to that of a rough or soft field takeoff in a landplane: to transfer the weight of the airplane to the wings as soon as possible, get airborne at a minimum airspeed, accelerate in ground effect to a safe climb speed, and climb out.

In most cases an experienced seaplane pilot can safely take off in rough water, but a beginner should not attempt to take off if the waves are too high. Using the proper procedure during rough water operation lessens the abuse of the floats, as well as the entire seaplane.

During rough water takeoffs, open the throttle to takeoff power just as the floats begin rising on a wave. This prevents the float bows from digging into the water and helps keep the spray away from the propeller. Apply a little more back elevator pressure than on a smooth water takeoff. This raises the nose to a higher angle and helps keep the float bows clear of the water.

Once on the step, the seaplane can begin to bounce from one wave crest to the next, raising its nose higher with each bounce, so each successive wave is struck with increasing severity. To correct this situation and to prevent a stall, smooth elevator pressures should be used to set up a fairly constant pitch attitude that allows the seaplane to skim across each successive wave as speed increases. Maintain control pressure to prevent the float bows from being pushed under the water surface, and to keep the seaplane from being thrown into the air at a high pitch angle and low airspeed. Fortunately, a takeoff in rough water is generally accomplished within a short time because if there is sufficient wind to make water rough, the wind is also strong enough to produce aerodynamic lift earlier and enable the seaplane to become airborne quickly.

The relationship of the spacing of the waves to the length of the floats is very important. If the wavelength is less than half the length of the floats, the seaplane is always supported by at least two waves at a time. If the wavelength is longer than the floats, only one wave at a time supports the seaplane. This creates dangerous pitching motions, and takeoff should not be attempted in this situation.

With respect to water roughness, consider the effect of a strong water current flowing against the wind. If the current is moving at 10 knots and the wind is blowing the opposite direction at 15 knots, the relative velocity between the water and the wind is 25 knots, and the waves will be as high as those produced in still water by a wind of 25 knots.

The advisability of canceling a proposed flight because of rough water depends on the size of the seaplane, wing loading, power loading, and, most importantly, the pilot's ability. As a general rule, if the height of the waves from trough to crest is more than half the height of the floats from keel to deck, takeoffs should not be attempted except by expert seaplane pilots. Chapter 8, Emergency Open Sea Operations, contains more information on rough water operations.

CONFINED AREA TAKEOFFS

If operating from a small body of water, an acceptable technique may be to begin the takeoff run while headed downwind, and then turning to complete the takeoff into the wind. This may be done by putting the seaplane on the step while on a downwind heading, then making a step turn into the wind to complete the takeoff. Exercise caution when using this technique since wind and centrifugal force are acting in the same direction and could result in the seaplane tipping over. The water area must be large enough to permit a wide step turn, and winds should be light.

In some cases, the water area may be adequate but surrounding high terrain creates a confined area. The terrain may also block winds, resulting in a glassy water situation as well. Such conditions may lead to a dangerous situation, especially when combined with a high density altitude. Even though landing was not difficult, careful planning is necessary for the takeoff. If the departure path leads over high terrain, consider circling back over the water after takeoff to gain altitude. If air temperatures have increased since landing, make the proper allowance for reduced takeoff performance due to the change in density altitude. Think about spending the night to take advantage of cooler temperatures the next morning. Although the decision may be difficult, consider leaving some cargo or passengers behind if takeoff safety is in question. It is far better to make a second trip to pick them up than to end your takeoff in the trees along the shore.

PERFORMANCE CONSIDERATIONS FOR TAKEOFF, CLIMB, CRUISE, AND LANDING

Since many pilots are accustomed to a certain level of performance from a specific make and model of land airplane, the changes in performance when that same airplane is equipped with floats can lead to trouble for a careless or complacent pilot. Floats weigh somewhat more than the wheeled landing gear they replace, but floats are designed to produce aerodynamic lift to offset some of the weight penalty. Generating lift inevitably creates induced drag, which imposes a small reduction in overall performance. By far the greatest impact on performance comes from the parasitic drag of the floats.

TAKEOFF

In a landplane, takeoff distance increases with additional takeoff weight for two reasons: it takes longer for the engine and propeller to accelerate the greater mass to lift-off speed, and the lift-off speed itself is higher because the wings must move faster to produce the extra lift required. For seaplanes, there are two more factors, both due to water drag. As seaplane weight increases, the floats sink deeper into the water, creating more drag during initial acceleration. As with the landplane, the seaplane must also accelerate to a higher airspeed to generate more lift, but the seaplane must overcome significantly more water drag force as speed increases. This extra drag reduces the rate of acceleration and results in a longer takeoff run.

Naturally, the location of the additional weight within the seaplane affects center of gravity (CG) location. Because of the way the floats respond to weight, the CG location affects the seaplane's handling characteristics on the water. If the CG is too far aft, it may be impossible to put the seaplane on the step. If the CG is located to one side of the centerline, one float will be pushed deeper into the water, resulting in more water drag on that side. Be sure to balance the fuel load between left and right wing tanks, and pay attention to how baggage or cargo is secured, so that the weight is distributed somewhat evenly from side to side. [Figure 5-1]

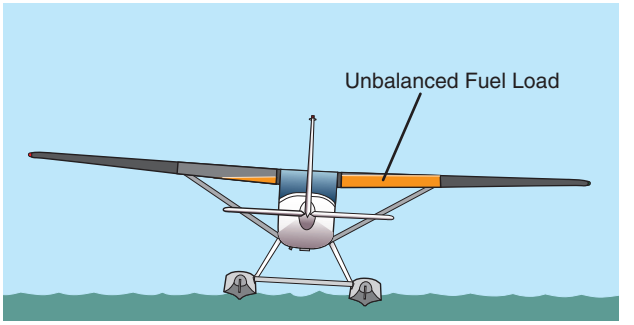


Figure 5-1. The location of the CG can affect seaplane handling.

The importance to weight and balance of pumping out the float compartments should be obvious. Water weighs 8.34 pounds per gallon, or a little over 62 pounds per cubic foot. Performance decreases whenever the wings and engine have to lift and carry useless water in a float compartment. Even a relatively small amount of water in one of the front or rear float compartments could place the airplane well outside of CG limits and seriously affect stability and control. Naturally, water also moves around in response to changes in attitude, and the sloshing of water in the floats can create substantial CG changes as the seaplane is brought onto the step or rotated into a climb attitude.

Some pilots use float compartments near the CG to stow iced fish or game from hunting expeditions. It is imperative to adhere to the manufacturer's weight and balance limitations and to include the weight and moment of float compartment contents in weight and balance calculations.

Density altitude is a very important factor in seaplane takeoff performance. High altitudes, high temperatures, high humidity, and even low barometric pressure can combine to rob the engine and propeller of thrust and the wings of lift. Seaplane pilots are encouraged to occasionally simulate high density altitude by using a reduced power setting for takeoff. This exercise should only be attempted where there is plenty of water area, as the takeoff run will be much longer. An experienced seaplane instructor can assist with choosing an appropriate power setting and demonstrating proper technique.

CLIMB AND CRUISE

When comparing the performance of an airplane with wheels to the same airplane equipped with floats, the drag and weight penalty of the floats usually results in a reduced climb rate for any given weight. Likewise, cruise speeds will usually be a little lower for a particular power setting. This in turn means increased fuel consumption and reduced range. Unless the airplane was originally configured as a seaplane, the performance and flight planning information for a landplane converted to floats will typically be found in the Supplements section rather than the Performance section of the Airplane Flight Manual (AFM) or Pilot's Operating Handbook (POH).

In addition to working within the limits of the seaplane's range, the pilot planning a cross-country flight must also consider the relative scarcity of refueling facilities for seaplanes. Amphibians have access to land airports, of course, but seaplanes without wheels need to find water landing facilities that also sell aviation fuel. While planning the trip, it is wise to call ahead to verify that the facilities have fuel and will be open at the intended arrival times. The Seaplane Pilots Association publishes a Water Landing Directory that is very helpful in planning cross-country flights.

In flight, the seaplane handles very much like the corresponding landplane. On many floatplanes, the floats decrease directional stability to some extent. The floats typically have more vertical surface area ahead of the airplane's CG than behind it. If the floats remain aligned with the airflow, this causes no problems, but if the airplane begins to yaw or skid, this vertical area acts somewhat like a large control surface that tends to increase the yaw, making the skid worse. [Figure 5-2] Additional vertical surface well behind the CG can counteract the yaw force created by the front of the floats, so many floatplanes have an auxiliary fin attached to the bottom of the tail, or small vertical surfaces added to the horizontal stabilizer. [Figure 5-3]

LANDING

Landplane pilots are trained to stay on the lookout for good places to land in an emergency, and to be able to plan a glide to a safe touchdown should the engine(s) fail. An airplane equipped with floats will usually have a steeper power-off glide than the same airplane with wheels. This means a higher rate of descent and a diminished glide range in the event of an engine failure, so the pilot should keep this in mind when spotting potential landing areas during cruising flight.

Seaplanes often permit more options in the event of an unplanned landing, since land can be used as well as water. While a water landing may seem like the only choice for a non-amphibious seaplane, a smooth landing on grass, dirt, or even a hard-surface runway usually causes very little damage to the floats or hull, and may frequently be the safer alternative.

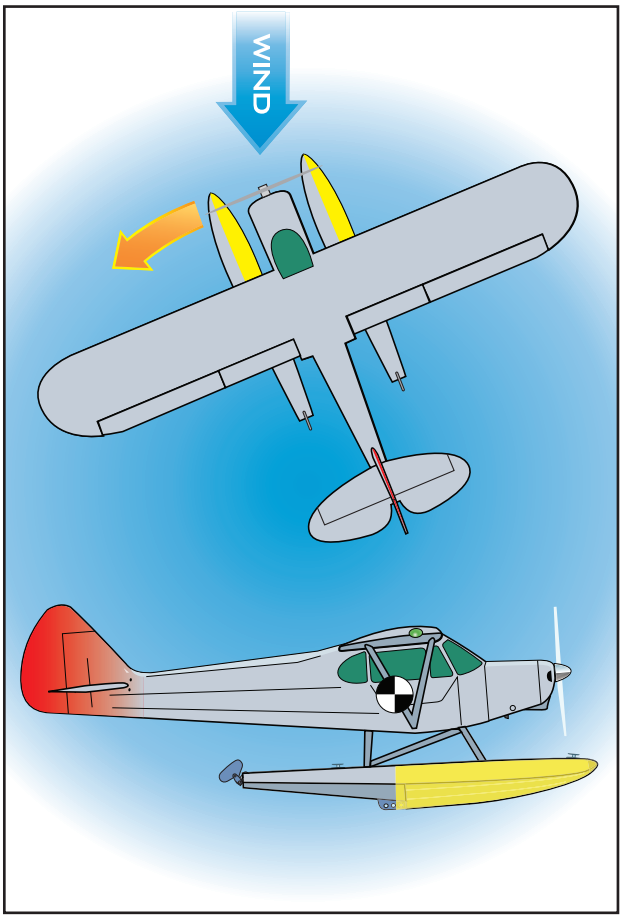


Figure 5-2. The side area of the floats can decrease directional stability.

Figure 5-3. Vertical surfaces added to the tail help restore directional stability.

FLIGHT CHARACTERISTICS OF SEAPLANES WITH HIGH THRUST LINES

Many of the most common flying boat designs have the engine and propeller mounted well above the airframe's CG. This results in some unique handling characteristics. The piloting techniques necessary to fly these airplanes safely are not intuitive and must be learned. Any pilot transitioning to such an airplane is strongly urged to obtain additional training specific to that model of seaplane.

Designing a seaplane with the engine and propeller high above the water offers some important advantages. The propeller is out of the spray during takeoffs and landings, and more of the fuselage volume can be used for passengers and cargo. The pilot usually sits well forward of the wing, and enjoys an excellent view in almost every direction.

Pilots who fly typical light twins are familiar with what happens when one engine is producing power and the other is not. The airplane tends to yaw toward the dead engine. This happens because the thrust line is located some distance from the airplane's CG. In some respects, this situation is similar to the single-engine seaplane with a high thrust line, except that the seaplane flies on one engine all the time. When power is applied, the thrust tends to pitch the nose down, and as power is reduced, the nose tends to rise. [Figure 5-4] This is exactly the opposite of what most pilots are accustomed to. In typical airplanes, including most floatplanes, applying power raises the nose and initiates a climb.

Naturally the magnitude of these pitch forces is proportional to how quickly power is applied or reduced. The most extreme pitch force logically results from a sudden engine failure, when the full thrust of the engine and its associated downward pitching force are suddenly removed. Forward thrust is replaced by the drag of a windmilling propeller, which adds a new upward pitching force. Since the seaplane is already trimmed with a considerable elevator force to counteract the downward pitch force of the engine, the nose pitches up abruptly. If this scenario occurs just after takeoff, when the engine has been producing maximum power, airspeed is low, and there is little altitude, the pilot must react instantly to overpower the upward pitching forces and push the nose down to avoid a stall.

The reversal of typical pitch forces also comes into play if porpoising should begin during a takeoff. As discussed in Chapter 4, Seaplane Operations - Preflight and Takeoffs, porpoising usually occurs when the planing angle is held too low by the pilot, forcing the front portion of the floats to drag until a wave builds up and travels back along the float. The same thing can happen with the hull of a flying boat, and the nose-down force of a high thrust line can make porpoising more likely. Once porpoising develops, the standard solution is to reduce power and let the airplane settle back into the water. But if power is reduced too quickly in a seaplane with a high-mounted engine, the sudden upward pitching force can combine with the porpoising to throw the seaplane into the air with inadequate airspeed for flight, decreasing thrust, and inadequate altitude for recovery.

Depending on how far the engine is from the airplane's CG, the mass of the engine can have detrimental effects on roll stability. Some seaplanes have the engine mounted within the upper fuselage, while oth-

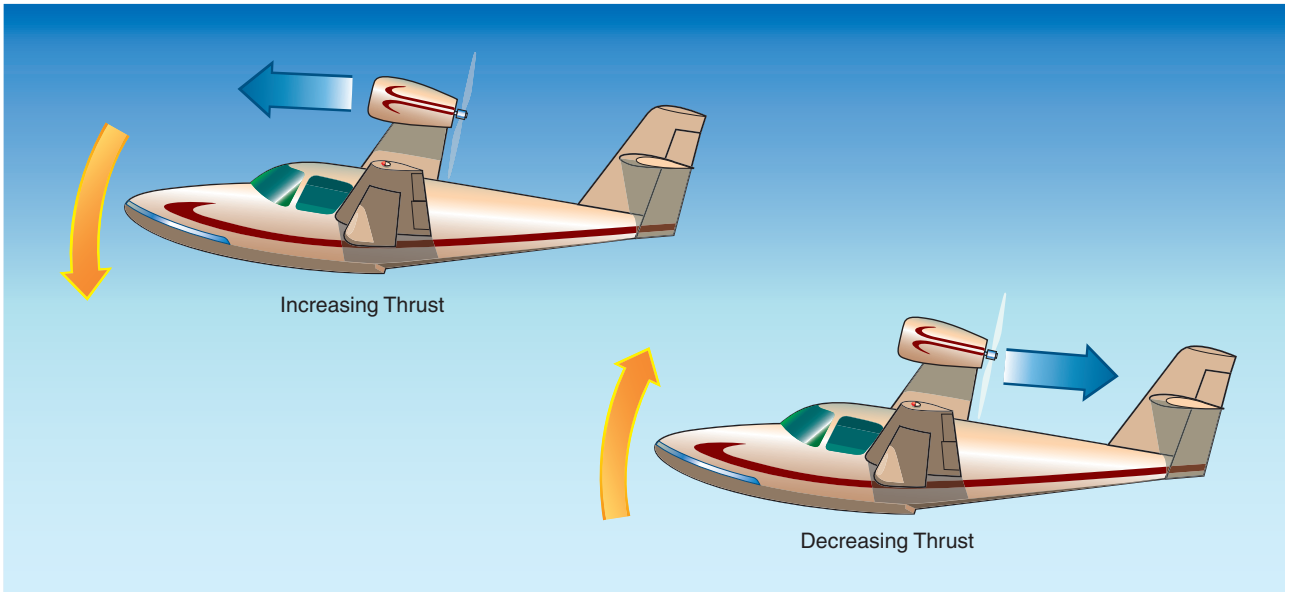


Figure 5-4. Pitching forces in seaplanes with a high thrust line.

ers have engines mounted on a pylon well above the main fuselage. If it is far from the CG, the engine can act like a weight at the end of a lever, and once started in motion it tends to continue in motion. Imagine balancing a hammer upright with the handle on the palm of the hand. [Figure 5-5]

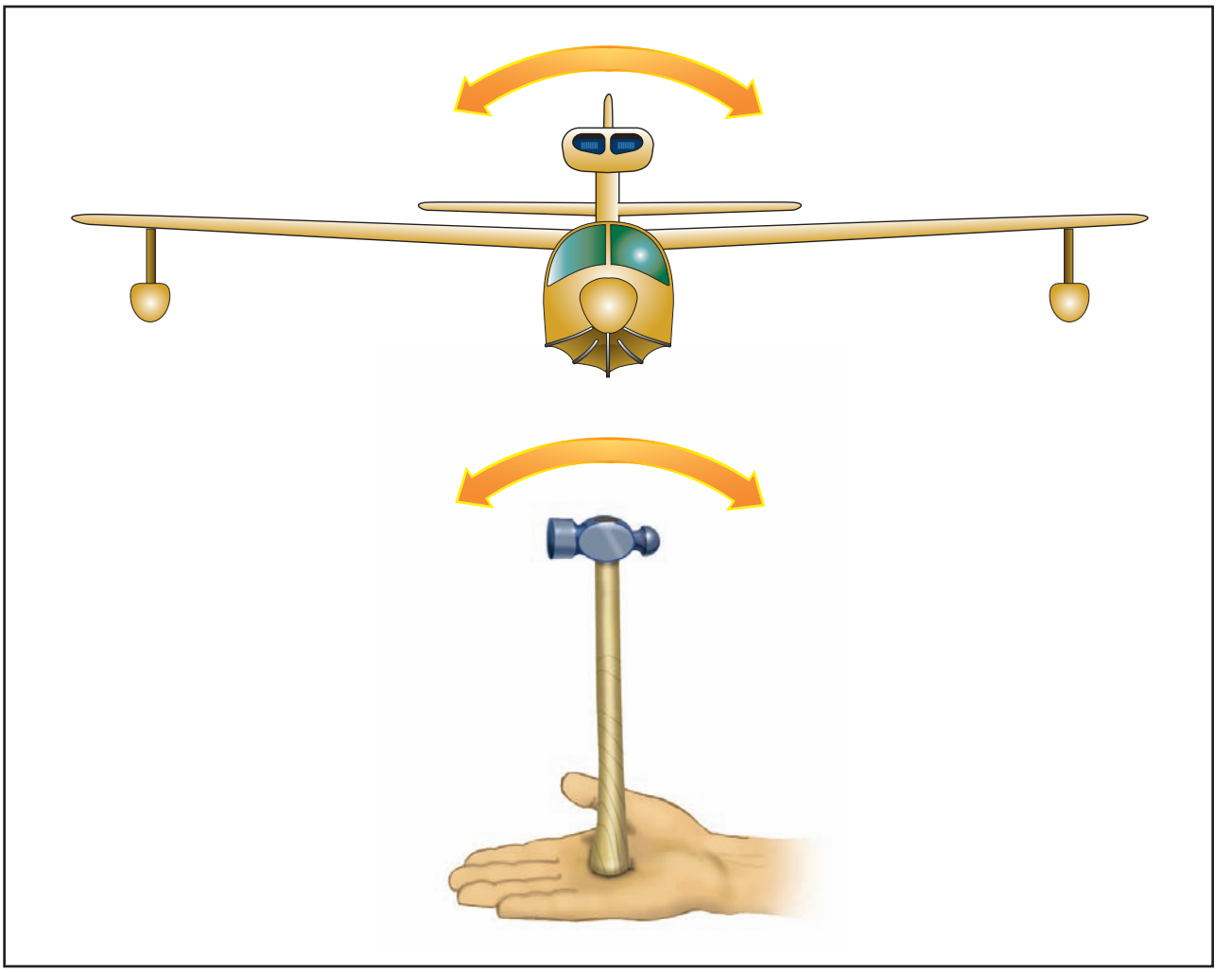


Figure 5-5. Roll instability with a high-mounted engine.

Finally, seaplanes with high-mounted engines may have unusual spin characteristics and recovery techniques. These factors reinforce the point that pilots need to obtain thorough training from a qualified instructor in order to operate this type of seaplane safely.

MULTIENGINE SEAPLANES

A rating to fly single-engine seaplanes does not entitle a pilot to fly seaplanes with two or more engines. The addition of a multiengine sea rating to a pilot certificate requires considerable additional training. Dealing with engine failures and issues of asymmetrical thrust are important aspects in the operation of multiengine seaplanes.

Chapter 6

Seaplane Operations-Landings

LANDING AREA RECONNAISSANCE AND PLANNING

When a landplane makes an approach at a towered airport, the pilot can expect that the runway surface will be flat and free of obstructions. Wind information and landing direction are provided by the tower. In water operations, the pilot must make a number of judgments about the safety and suitability of the landing area, evaluate the characteristics of the water surface, determine wind direction and speed, and choose a landing direction. It is rare for active airport runways to be used by other vehicles, but common for seaplane pilots to share their landing areas with boats, ships, swimmers, jet-skis, wind-surfers, or barges, as well as other seaplanes.

It is usually a good practice to circle the area of intended landing and examine it thoroughly for obstructions such as pilings or floating debris, and to note the direction of movement of any boats that may be in or moving toward the intended landing site. Even if the boats themselves will remain clear of the landing area, look for wakes that could create hazardous swells if they move into the touchdown zone. This is also the time to look for indications of currents in moving water. Note the position of any buoys marking preferred channels, hidden dangers, or off-limits areas such as no-wake zones or swimming beaches. Just as it is a good idea in a landplane to get a mental picture of the taxiway arrangement at an unfamiliar airport prior to landing, the seaplane pilot should plan a taxi route that will lead safely and efficiently from the intended touchdown area to the dock or mooring spot. This is especially important if there is a significant wind that could make turns difficult while taxiing or necessitate sailing backward or sideways to the dock. If the water is clear, and there is not much wind, it is possible to see areas of waterweeds or obstructions lying below the surface. Noting their position before landing can prevent fouling the water rudders with weeds while taxiing, or puncturing a float on a submerged snag. In confined areas, it is essential to verify before landing that there is sufficient room for a safe takeoff under the conditions that are likely to prevail at the intended departure time. While obstruction heights are regulated in the vicinity of land airports and tall structures are usually well marked, this is not the case with most water landing areas. Be alert for towers, cranes, powerlines, and the masts of ships and boats on the approach path. Finally, plan a safe, conservative path for a go-around should the landing need to be aborted.

Most established seaplane bases have a windsock, but if one is not visible, there are many other cues to gauge the wind direction and speed prior to landing. If there are no strong tides or water currents, boats lying at anchor weathervane and automatically point into the wind. Be aware that some boats also set a stern anchor, and thus do not move with changes in wind direction. There is usually a glassy band of calm water on the upwind shore of a lake. Sea gulls and other waterfowl usually land into the wind and typically head into the wind while swimming on the surface. Smoke, flags, and the set of sails on sailboats also provide the pilot with a fair approximation of the wind direction. If there is an appreciable wind velocity, wind streaks parallel to the wind form on the water. In light winds, they appear as long, narrow, straight streaks of smooth water through the wavelets. In winds of approximately 10 knots or more, foam accents the streaks, forming distinct white lines. Although wind streaks show direction very accurately, the pilot must still determine which end of the wind streak is upwind. For example, an east-west wind streak could mean a wind from the east or the west—it is up to the pilot to determine which. [Figure 6-1]

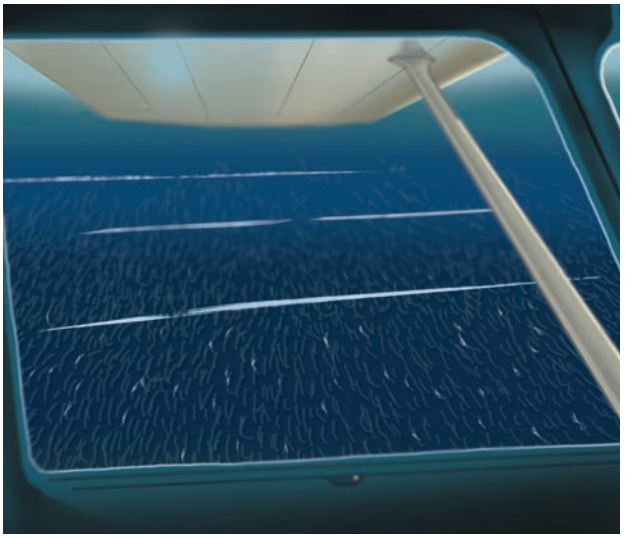


Figure 6-1. Wind streaks show wind direction accurately, but the pilot must determine which end of the streak is upwind.

If there are whitecaps or foam on top of the waves, the foam appears to move into the wind. This illusion is caused by the motion of the waves, which move more quickly than the foam. As the waves pass under the foam, the foam appears to move in the opposite direction. The shape of shorelines and hills influences wind direction, and may cause significant variations from one area to another. Do not assume that because the wind is from a certain direction on this side of the lake that it is from the same direction on the other side.

Except for glassy water, it is usually best to plan to land on the smoothest water available. When a swell system is superimposed on a second swell system, some of the waves may reinforce each other, resulting in higher waves, while other waves cancel each other out, leaving smoother areas. Often it is possible to avoid the larger waves and land on the smooth areas.

In seaplanes equipped with retractable landing gear (amphibians), it is extremely important to make certain that the wheels are retracted when landing on water. Wherever possible, make a visual check of the wheels themselves, in addition to checking the landing gear position indicators. A wheels-down landing on water is almost certain to capsize the seaplane, and is far more serious than landing the seaplane on land with the wheels up. Many experienced seaplane pilots make a point of saying out loud to themselves before every water landing, "This is a **water** landing, so the wheels should be **up**." Then they confirm that each wheel is up using externally mounted mirrors and other visual indicators. Likewise, they verbally confirm that the wheels are down before every landing on land. The water rudders are also retracted for landings.

When planning the landing approach, be aware that the seaplane has a higher sink rate than its landplane counterpart at the same airspeed and power setting. With some practice, it becomes easy to land accurately on a predetermined spot. Landing near unfamiliar shorelines increases the possibility of encountering submerged objects and debris.

Besides being safe, it is also very important for seaplane pilots to make a conscious effort to avoid inflicting unnecessary noise on other people in the area. Being considerate of others can often mean the difference between a warm welcome and the banning of future seaplane activity in a particular location. The actions of one pilot can result in the closing of a desirable landing spot to all pilots. People with houses along the shore of a lake usually include the quiet as one of the reasons they chose to live there. Sometimes high terrain around a lake or the local topography of a shoreline can reflect and amplify sound, so that a seaplane sounds louder than it would otherwise. A good practice is to cross populated shorelines no lower than 1,000 feet AGL whenever feasible. To the extent possible consistent with safety, avoid overflying houses during the landing approach. If making a go-around, turn back over the water for the climbout, and reduce power slightly after attaining a safe altitude and airspeed. A reduction of 200 r.p.m. makes a significant difference in the amount of sound that reaches the ground.

LANDING

In water landings, the major objectives are to touch down at the lowest speed possible, in the correct pitch attitude, without side drift, and with full control throughout the approach, landing, and transition to taxiing.

The correct pitch attitude at touchdown in a landplane varies between wide limits. For example, wheel landings in an airplane with conventional-gear, require a nearly flat pitch attitude, with virtually zero angle of attack, while a full-stall landing on a short field might call for a nose-high attitude. The touchdown attitude for a seaplane typically is very close to the attitude for taxiing on the step. The nose may be a few degrees higher. The objective is to touch down on the steps,

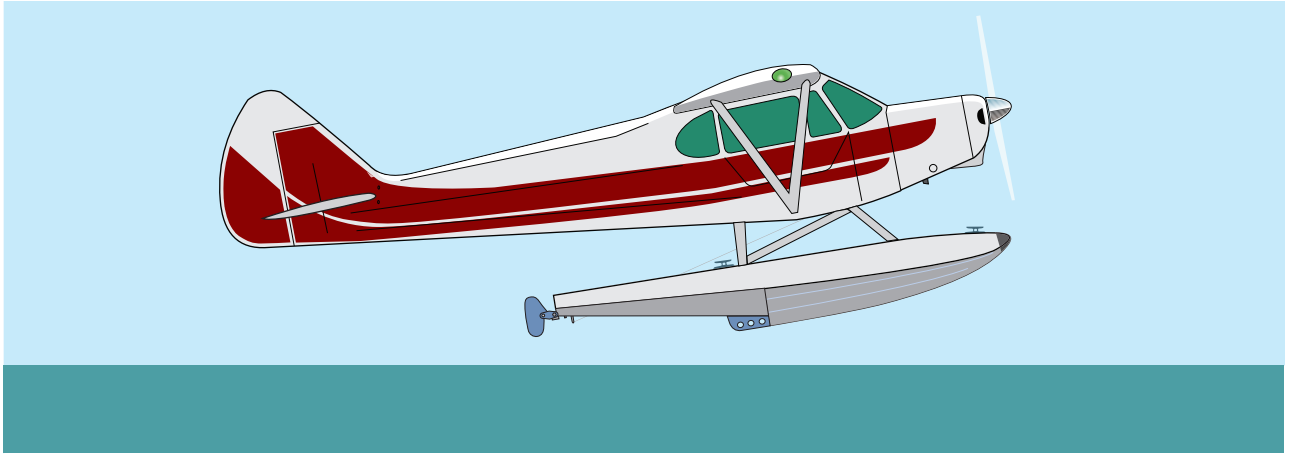


Figure 6-2. The touchdown attitude for most seaplanes is almost the same as for taxiing on the step.

with the sterns of the floats near or touching the water at the same time. [Figure 6-2] If the nose is much higher or lower, the excessive water drag puts unnecessary stress on the floats and struts, and can cause the nose to pitch down, allowing the bows of the floats to dig into the water. Touching down on the step keeps water drag forces to a minimum and allows energy to dissipate more gradually.

NORMAL LANDING

Make normal landings directly into the wind. Seaplanes can be landed either power-off or power-on, but power-on landings are generally preferred because they give the pilot more positive control of the rate of sink and the touchdown spot. To touch down at the slowest possible speed, extend the flaps fully. Use flaps, throttle, and pitch to control the glidepath and establish a stabilized approach at the recommended approach airspeed. The techniques for glidepath control are similar to those used in a landplane.

As the seaplane approaches the water's surface, smoothly raise the nose to the appropriate pitch attitude for touchdown. As the floats contact the water, use gentle back pressure on the elevator control to compensate for any tendency of the nose to drop. When the seaplane is definitely on the water, close the throttle and maintain the touchdown attitude until the seaplane begins to come off the step. Once it begins to settle into the plowing attitude, apply full up elevator to keep the nose as high as possible and minimize spray hitting the propeller.

As the seaplane slows to taxi speed, lower the water rudders to provide better directional control. Raise the flaps and perform the after-landing checklist.

The greater the speed difference between the seaplane and the water, the greater the drag at touchdown, and the greater the tendency for the nose to pitch down. This is why the touchdown is made at the lowest possible speed for the conditions. Many landplane pilots transitioning to seaplanes are surprised at the shortness of the landing run, in terms of both time and distance. It is not uncommon for the landing run from touchdown to idle taxi to take as little as 5 or 6 seconds.

Sometimes the pilot chooses to remain on the step after touchdown. To do so, merely add sufficient power and maintain the planing attitude immediately after touchdown. It is important to add enough power to prevent the seaplane from coming off the step, but not so much that the seaplane is close to flying speed. With too much taxi speed, a wave or swell could throw the seaplane into the air without enough speed to make a controlled landing. In that situation, the seaplane may stall and contact the water in a nose-down attitude, driving the float bows underwater and capsizing the seaplane. Raising the flaps can help keep the seaplane firmly on the water. To end the step taxi, close the throttle and gradually apply full up elevator as the seaplane slows.

CROSSWIND LANDING

Landing directly into the wind might not be practical due to water traffic in the area, obstructions on or under the water, or a confined landing area, such as a river or canal. In landing a seaplane with any degree of crosswind component, the objectives are the same as when landing a landplane: to minimize sideways drift during touchdown and maintain directional control afterward. Because floats have so much more side area than wheels, even a small amount of drift at touchdown can create large sideways forces. This is important because enough side force can lead to capsizing. Also, the float hardware is primarily designed to take vertical and fore-and-aft loads rather than side loads.

If the seaplane touches down while drifting sideways, the sudden resistance as the floats contact the water creates a skidding force that tends to push the downwind float deeper into the water. The combination of the skidding force, wind, and weathervaning as the seaplane slows down can lead to a loss of directional control and a waterloop. If the downwind float submerges and the wingtip contacts the water when the seaplane is moving at a significant speed, the seaplane could flip over. [Figure 6-3 on next page]

Floatplanes frequently have less crosswind component capability than their landplane counterparts. Directional control can be more difficult on water because the surface is more yielding, there is less surface friction than on land, and seaplanes lack brakes. These factors increase the seaplane's tendency to weathervane into the wind.

One technique sometimes used to compensate for crosswinds during water operations is the same as that used on land; that is, by lowering the upwind wing while holding a straight course with rudder. This creates a slip into the wind to offset the drifting tendency. The apparent movement of the water's surface during the landing approach can be deceiving. Wave motion may make it appear that the water is moving sideways, but although the wind moves the waves, the water itself remains virtually stationary. Waves are simply an up-and-down motion of the water surface—the water itself is not moving sideways. To detect side drift over water and maintain a straight path during landing, pick a spot on the shore or a stationary buoy as an aim point. Lower the upwind wing just enough to stop any drift, and use rudder to maintain a straight

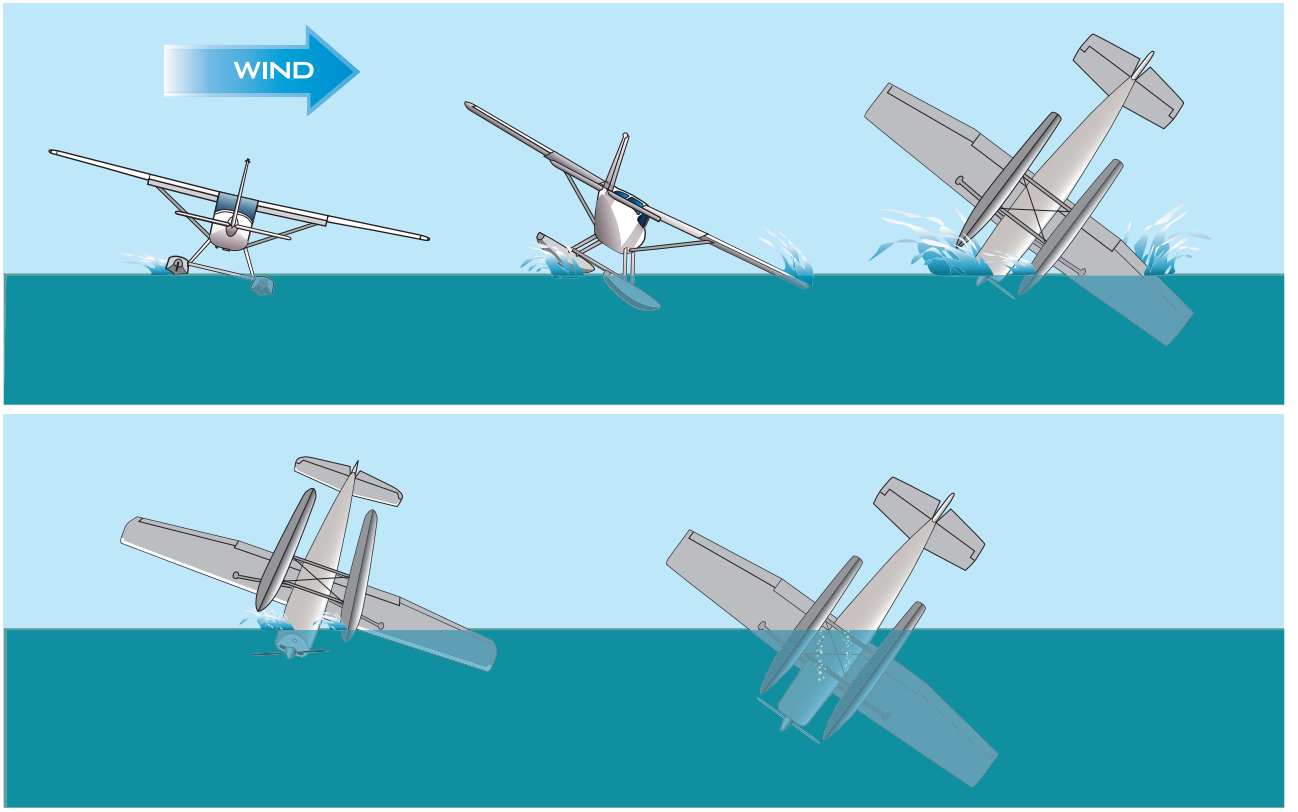


Figure 6-3. Improper technique or excessive crosswind forces can result in an accident.

path. As the seaplane touches down on the upwind float, the water drag will quickly slow the seaplane and the other float will touch down as aerodynamic lift decreases. Close the throttle, and as the seaplane's speed dissipates, increase aileron to hold the upwind wing down. The seaplane is most unstable as it is coming off the step and transitioning through the plowing phase. Be ready for the seaplane to weathervane into the wind as the air rudder becomes less effective. Many pilots make a turn to the downwind side after landing to minimize weathervaning until the seaplane has slowed to taxi speed. Since the seaplane will weathervane sooner or later, this technique reduces the centrifugal force on the seaplane by postponing weathervaning until speed has dissipated. Once the seaplane settles into the displacement attitude, lower the water rudders for better directional control. [Figure 6-4]

Another technique used to compensate for crosswinds (preferred by many seaplane pilots) is the downwind arc method. Seaplanes need not follow a straight path during landing, and by choosing a curved path, the pilot can create a sideward force (centrifugal force) to offset the crosswind force. This is done by steering the seaplane in a downwind arc as shown in figure 6-5. During the approach, the pilot merely plans a curved landing path and follows this path to produce sufficient centrifugal force to counter the wind force. During the landing run, the pilot can adjust the amount of centrifugal force by varying rudder pressure to increase or decrease the rate of turn. This technique allows the pilot to compensate for a changing wind force during the water run.

Figure 6-5 shows that the tightest curve of the downwind arc is during the time the seaplane is traveling at low speed. Faster speeds reduce the crosswind effect, and at very slow speeds the seaplane can weathervane into the wind without imposing large side loads or stresses. Again, experience plays an important part in successful operation during crosswinds. It is essential that all seaplane pilots have thorough knowledge and skill in these maneuvers.

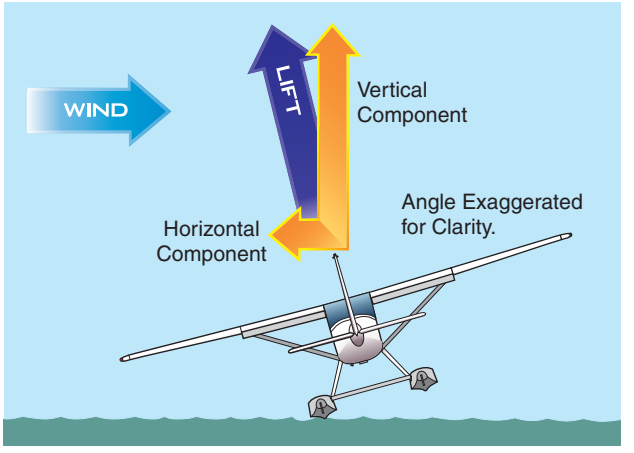


Figure 6-4. Dropping the upwind wing uses a horizontal component of lift to counter the drift of a crosswind.

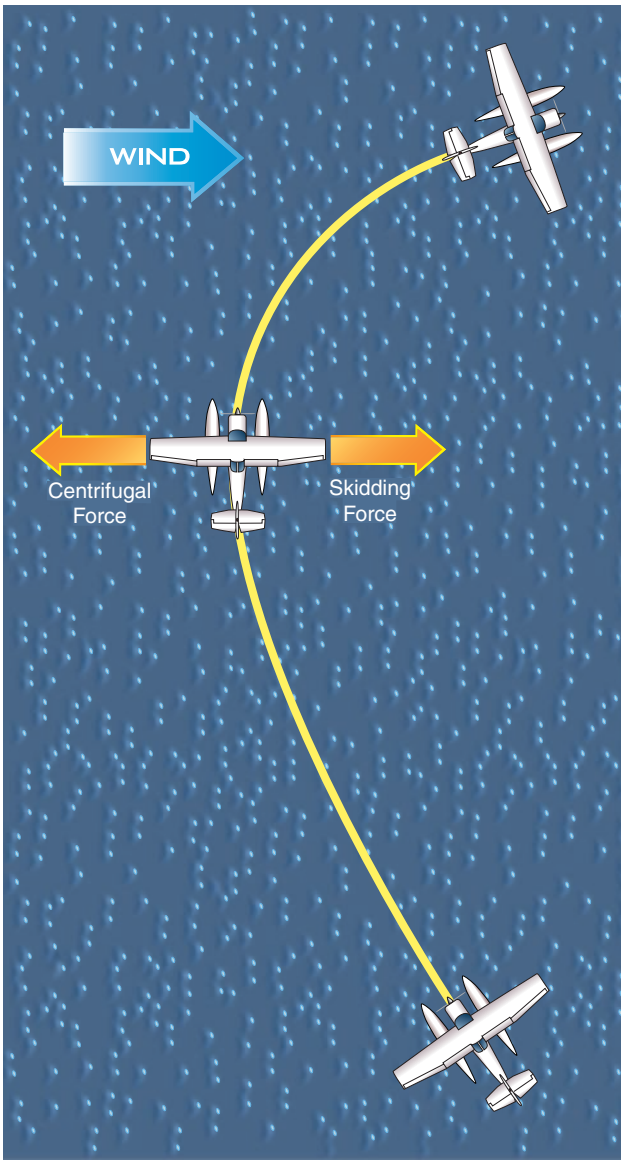


Figure 6-5. A downwind arc is one way to compensate for a crosswind.

DOWNWIND LANDING

Although downwind landings often require significantly more water area, there are occasions when they are more convenient or even safer than landing into the wind. Sometimes landing upwind would mean a long, slow taxi back along the landing path to get to the dock or mooring area. If winds are less than 5 knots and there is ample room, landing downwind could save taxi time. Unless the winds are light, a downwind landing is seldom necessary. Before deciding to land downwind, the pilot needs a thorough knowledge of the landing characteristics of the seaplane as well as the environmental factors in the landing area.

As with a downwind landing in a landplane, the main concern for a seaplane is the additional groundspeed added by the wind to the normal approach speed. The airspeed, of course, is the same whether landing upwind or downwind, but the wind decreases groundspeed in upwind landings and increases groundspeed in downwind landings. While a landplane pilot seldom thinks about the additional force placed on the landing gear by a higher groundspeed at touchdown, it is a serious concern for the seaplane pilot. A small increase in water speed translates into greatly increased water drag as the seaplane touches down, increasing the tendency of the seaplane to nose over. In light winds, this usually presents little problem if the pilot is familiar with how the seaplane handles when touching down at higher speeds, and is anticipating the increased drag forces. In higher winds, the nose-down force may exceed the ability of the pilot or the flight controls to compensate, and the seaplane will flip over at high speed. If the water's surface is rough, the higher touchdown speed also subjects the floats and airframe to additional pounding.

If there is a strong current, the direction of water flow is a major factor in choosing a landing direction. The speed of the current, a confined landing area, or the surface state of the water may influence the choice of landing direction more than the direction of the wind. In calm or light winds, takeoffs usually are made in the same direction as the flow of the current, but landings may be made either with or against the flow of the current, depending on a variety of factors. For example, on a narrow river with a relatively fast current, the speed of the current is often more significant than wind direction, and the need to maintain control of the seaplane at taxi speed after the landing run may present more challenges than the landing itself. It is imperative that even an experienced seaplane pilot obtain detailed information about such operations before attempting them for the first time. Often the best source of information is local pilots with comprehensive knowledge of the techniques that work best in specific locations and conditions.

GLASSY WATER LANDING

Flat, calm, glassy water certainly looks inviting and may give the pilot a false sense of safety. By its nature, glassy water indicates no wind, so there are no concerns about which direction to land, no crosswind to consider, no weathervaning, and obviously no rough water. Unfortunately, both the visual and the physical characteristics of glassy water hold potential hazards for complacent pilots. Consequently, this surface condition is frequently more dangerous than it appears for a landing seaplane.

The visual aspects of glassy water make it difficult to judge the seaplane's height above the water. The lack of surface features can make accurate depth perception very difficult, even for experienced seaplane pilots. Without adequate knowledge of the seaplane's

height above the surface, the pilot may flare too high or too low. Either case can lead to an upset. If the seaplane flares too high and stalls, it will pitch down, very likely hitting the water with the bows of the floats and flipping over. If the pilot flares too late or not at all, the seaplane may fly into the water at relatively high speed, landing on the float bows, driving them underwater and flipping the seaplane. [Figure 6-6]

Besides the lack of surface features, the smooth, reflecting surface can lead to confusing illusions as clouds or shore features are reproduced in stunning detail and full color. When the water is crystal clear and glassy, the surface itself is invisible, and pilots may inadvertently judge height by using the bottom of the lake as a reference, rather than the water surface.

The lack of surface texture also presents a physical characteristic that adds slightly to the risk of glassy water landings. A nice smooth touchdown can result in faster deceleration than expected, for the same reason that the floats seem to stick to the surface during glassy water takeoffs: there is less turbulence and fewer air bubbles between the float bottoms and the water, which effectively increases the wetted surface area of the floats and causes higher drag forces. Naturally, this sudden extra drag at touchdown tends to pull the nose down, but if the pilot is expecting it and maintains the planing attitude with appropriate back pressure, the tendency is easily controlled and presents no problem.

There are some simple ways to overcome the visual illusions and increase safety during glassy water landings. Perhaps the simplest is to land near the shoreline, using the features along the shore to gauge altitude. Be certain that the water is sufficiently deep and free of obstructions by performing a careful inspection from a safe altitude. Another technique is to make the final approach over land, crossing the shoreline at the lowest possible safe altitude so that a reliable height reference is maintained to within a few feet of the water surface.

When adequate visual references are not available, make glassy water landings by establishing a stable descent in the landing attitude at a rate that will provide a positive, but not excessive, contact with the water. Recognize the need for this type of landing in ample time to set up the proper final approach. Always perform glassy water landings with power. Perform a normal approach, but prepare as though intending to land at an altitude well above the surface. For example, in a situation where a current altimeter setting is not available and there are few visual cues, this altitude might be 200 feet above the surface. Landing preparation includes completion of the landing checklist and extension of flaps as recommended by the manufacturer. The objective is to have the seaplane ready to contact the water soon after it reaches the target altitude, so at approximately 200 feet above the surface, raise the nose to the attitude normally used for touchdown, and adjust the power to provide a constant descent rate of no more than 150 feet per minute (f.p.m.) at an airspeed approximately 10 knots above stall speed. Maintain this attitude, airspeed, and rate of descent until the seaplane contacts the water. Once the landing attitude and power setting are established, the airspeed and descent rate should remain the same without further adjustment, and the pilot should closely monitor the instruments to maintain this stable glide. Power should only be changed if the airspeed or rate of descent deviate from the desired values. Do not flare, but let the seaplane fly onto the water in the landing attitude. [Figure 6-7]

Upon touchdown, apply gentle back pressure to the elevator control to maintain the same pitch attitude. Close the throttle only after the seaplane is firmly on the water. Three cues provide verification through three different senses—vision, hearing, and body sensation. The pilot sees a slight nose-down pitch at touchdown and perhaps spray thrown to the sides by the floats, hears the sound of the water against the floats, and feels the deceleration force. Accidents have resulted from cutting the power suddenly after the initial touchdown. To the pilot's surprise, a skip had taken place and as the throttle closed, the seaplane was 10 to 15 feet in the air and not on the water, resulting in a stall and substantial damage. Be sure all of the cues

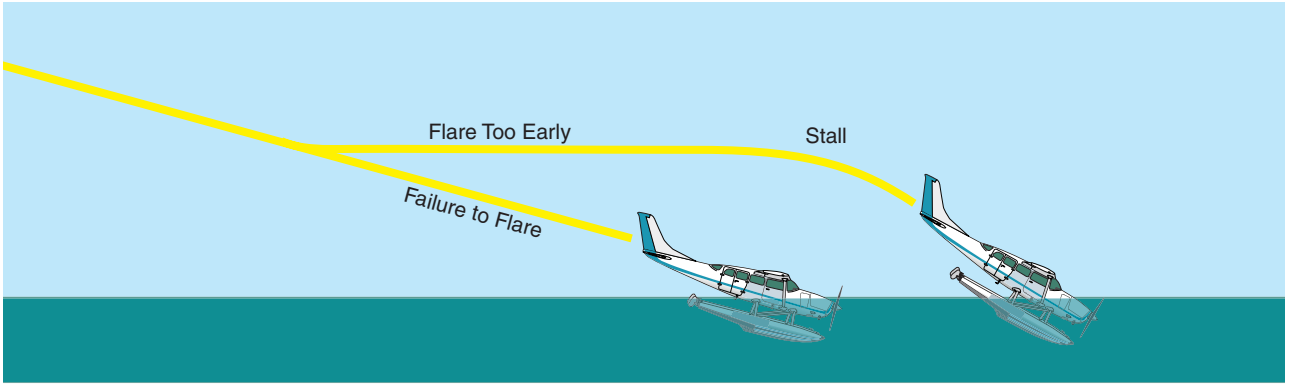


Figure 6-6. The consequences of misjudging altitude over glassy water can be catastrophic.

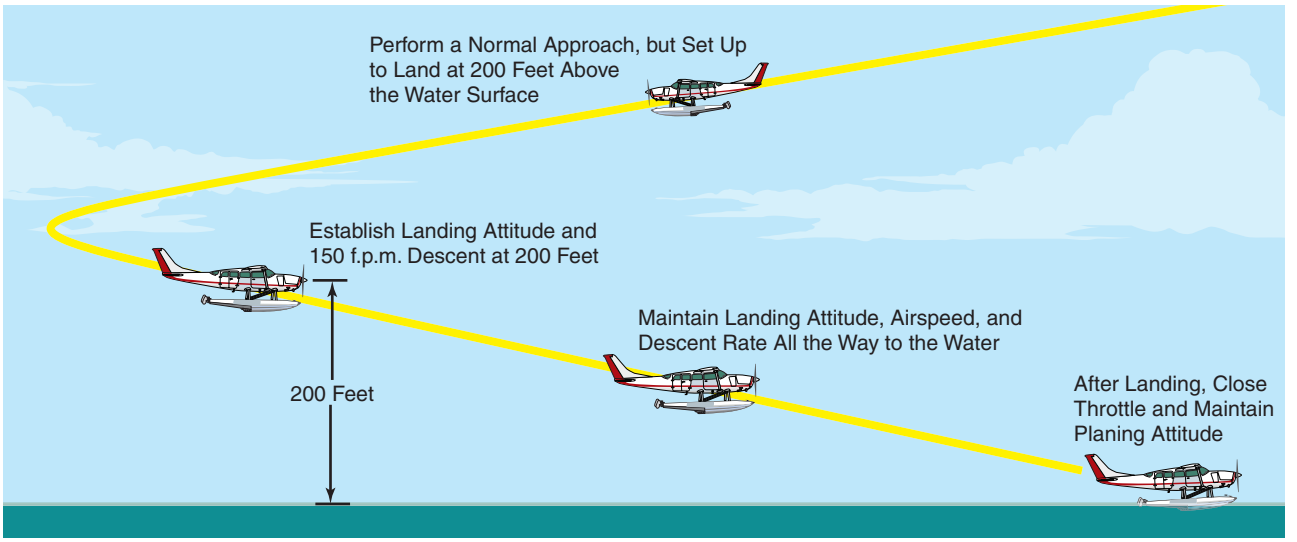

Perform a Normal Approach, but Set Up
to Land at 200 Feet Above
the Water Surface
Establish Landing Attitude and
150 f.p.m. Descent at 200 Feet
200 Feet
Maintain Landing Attitude, Airspeed, and
Descent Rate All the Way to the Water
After Landing, Close
Throttle and Maintain
Planing Attitude

Figure 6-7. Hold the landing attitude, airspeed, and 150 f.p.m. rate of descent all the way to the surface.

indicate that the seaplane is staying on the water before closing the throttle. After the seaplane settles into a displacement taxi, complete the after-landing checklist and lower the water rudders.

An accurately set altimeter may allow the pilot to set up for the touchdown at an altitude somewhat closer to the surface. If the pilot can be certain that the landing configuration and 150 f.p.m. descent will be established well above the water's surface, starting the final glide nearer the surface shortens the descent time and overall landing length.

This technique usually produces a safe, comfortable landing, but the long, shallow glide consumes considerable landing distance. Be certain there is sufficient room for the glide, touchdown, and water run.

ROUGH WATER LANDING

Rough is a very subjective and relative term. Water conditions that cause no difficulty for small boats can be too rough for a seaplane. Likewise, water that poses no challenge to a large seaplane or an experienced pilot may be very dangerous for a smaller seaplane or a less experienced pilot.

Describing a typical or ideal rough water landing procedure is impractical because of the many variables that affect the water's surface. Wind direction and speed must be weighed along with the surface conditions of the water. In most instances, though, make the approach the same as for any other water landing. It may be better, however, to level off just above the water surface and increase the power sufficiently to maintain a rather flat attitude until conditions appear more acceptable, and then reduce the power to touch down. If severe bounces occur, add power and lift off to search for a smoother landing spot.

In general, make the touchdown at a somewhat flatter pitch attitude than usual. This prevents the seaplane from being tossed back into the air at a dangerously low airspeed, and helps the floats to slice through the tops of the waves rather than slamming hard against them. Reduce power as the seaplane settles into the water, and apply back pressure as it comes off the step to keep the float bows from digging into a wave face. If a particularly large wave throws the seaplane into the air before coming off the step, be ready to apply full power to go around.

Avoid downwind landings on rough water or in strong winds. Rough water is usually an indication of strong winds, and vice versa. Although the airspeed for landing is the same, wind velocity added to the seaplane's normal landing speed can result in a much higher groundspeed, imposing excessive stress on the floats, increasing the nose-down tendency at touchdown, and prolonging the water run, since more kinetic energy must be dissipated. As the seaplane slows, the tendency to weathervane may combine with the motion created by the rough surface to create an unstable situation. In strong winds, an upwind landing means a much lower touchdown speed, a shorter water run, and subsequently much less pounding of the floats and airframe.

Likewise, crosswind landings on rough water or in strong winds can leave the seaplane vulnerable to capsizing. The pitching and rolling produced by the water motion increases the likelihood of the wind lifting a wing and flipping the seaplane.

There is additional information on rough water landings in Chapter 8, Emergency Open Sea Operations.

CONFINED AREA LANDING

One of the first concerns when considering a landing in a confined area is whether it is possible to get out

again. For most seaplanes, the takeoff run is usually much longer than the landing run. Before landing, the pilot should also consider the wind and surface conditions expected when it is time to leave. If the seaplane lands into a stiff breeze on water with small waves, it might be more difficult to leave the next morning when winds are calm and the water is glassy. Conversely, if the seaplane lands in the morning when the air temperature is low, departure in the hot afternoon might mean a significant loss in takeoff performance due to the density altitude.

It is especially important to carefully inspect the landing area for shallow areas, obstructions, or other hazards. After touchdown is not the time to discover factors that make a confined landing area even smaller or less usable than originally supposed. Evaluation of the landing area should include approach and departure paths. Terrain that rises faster than the seaplane can climb is an obvious consideration, both for the eventual takeoff as well as in case of a go-around during landing. If climbout over the terrain is not easily within the seaplane's capabilities, be certain there is sufficient room to make a gentle turn back over the water for climb.

GO-AROUND

Whenever landing conditions are not satisfactory, execute a go-around. Potential conflicts with other aircraft, surface vessels or swimmers in the landing area, recognition of a hazard on the water, wind shear, wake turbulence, water surface conditions, mechanical failure, or an unstabilized landing approach are a few of the reasons to discontinue a landing attempt. Climb to a safe altitude while executing the go-around checklist, then evaluate the situation, and make another approach under more favorable conditions. Remember that it is often best to make a gentle climbing turn back over the water to gain altitude, rather than climbing out over a shoreline with rising terrain or noise-sensitive areas. The go-around is a normal maneuver that must be practiced and perfected like any other maneuver.

EMERGENCY LANDING

Emergency situations occurring within gliding distance of water usually present no landing difficulty. Although there is some leeway in landing attitude, it is important to select the correct type of landing for the water conditions. If the landing was due to an engine failure, an anchor and paddle are useful after the landing is completed.

Should the emergency occur over land, it is usually possible to land a floatplane with minimal damage in a smooth field. Snow covered ground is ideal if there are no obstructions. The landing should be at a slightly flatter attitude than normal, a bit fast, and directly into the wind. If engine power is available, landing with a small amount of power helps maintain the flatter attitude. Just before skidding to a stop, the tail will begin to rise, but the long front portions of the floats stop the rise and keep the seaplane from flipping over.

A night water landing should generally be considered only in an emergency. They can be extremely dangerous due to the difficulty of seeing objects in the water, judging surface conditions, and avoiding large waves or swell. If it becomes necessary to land at night in a seaplane, seriously consider landing at a lighted airport. An emergency landing can be made on a runway in seaplanes with little or no damage to the floats or hull. Touchdown is made with the keel of the floats or hull as nearly parallel to the surface as possible. After touchdown, apply full back elevator and additional power to lessen the rapid deceleration and nose-over tendency. Do not worry about getting stopped with additional power applied after touchdown. It will stop! The reason for applying power is to provide additional airflow over the elevator to help keep the tail down.

In any emergency landing on water, be as prepared as possible well before the landing. Passengers and crew should put on their flotation gear and adjust it properly. People sitting near doors should hold the liferafts or other emergency equipment in their laps, so no one will need to try to locate or pick it up in the scramble to exit the seaplane. Unlatch all the doors prior to touchdown, so they do not become jammed due to distortion of the airframe. Brief the passengers thoroughly on what to do during and after the landing. These instructions should include how to exit the seaplane even if they cannot see, how to get to the surface, and how to use any rescue aids.

POSTFLIGHT PROCEDURES

After landing, lower the water rudders and complete the after-landing checklist. The flaps are usually raised after landing, both to provide better visibility and to reduce the effects of wind while taxiing. It is a good practice to remain at least 50 feet from any other vessel during the taxi.

After landing, secure the seaplane to allow safe unloading, as well as to keep winds and currents from moving it around. Knowing a few basic terms makes the following discussions easier to understand. Anchoring uses a heavy hook connected to the seaplane by a line or cable. This **anchor** digs into the bottom due to tension on the line, and keeps the seaplane from drifting. **Mooring** means to tie the seaplane to a fixed structure on the surface. The seaplane may be moored to a floating buoy, or to a pier, or to a floating raft. For this discussion, **docking** means securing the seaplane to a permanent structure fixed to the shore. To **beach** a seaplane means to pull it up onto a suitable shore surface, so that its weight is supported by relatively dry ground

rather than water. **Ramping** is defined as using a ramp to get the seaplane out of the water and onto the shore.

ANCHORING

Anchoring is the easiest way to secure a seaplane on the water surface. The area selected should be out of the way of moving vessels, and in water deep enough that the seaplane will not be left aground during low tide. The holding characteristics of the bottom are important in selecting an appropriate anchorage. The length of the anchor line should be about seven times the depth of the water. After dropping the anchor with the seaplane headed into the wind, allow the seaplane to drift backward to set the anchor. To be sure the anchor is holding, watch two fixed points somewhere to the side of the seaplane, one farther away than the other, that are aligned with each other, such as a tree on the shore and a mountain in the distance. If they do not remain aligned, it means that the seaplane is drifting and dragging its anchor along the bottom. The nautical term for when two objects appear directly in line, one behind the other, is "in range" and the two objects are called a range.

When choosing a place to anchor, think about what will happen if the wind shifts. Allow enough room so that the seaplane can swing around the anchor without striking nearby obstacles or other anchored vessels. Be certain the water rudders are retracted, as they can interfere with the seaplane's ability to respond to wind shifts.

If anchoring the seaplane overnight or for longer periods of time, use a heavier anchor and be sure to comply with maritime regulations for showing an anchor light or daytime visual signals when required. [Figure 6-8]

When leaving the seaplane anchored for any length of time, it is a good idea to secure the controls with the elevator down and rudder neutral. Since the seaplane can rotate so that it always faces into the wind, this forces the nose down and reduces the angle of attack, keeping lift and wind resistance at a minimum.

MOORING

Mooring a seaplane eliminates the problem of the anchor dragging. A permanent mooring installation consists of a heavy weight on the bottom connected by a chain or cable to a floating buoy with provisions for securing mooring lines. Approach a mooring at a very low speed and straight into the wind. To keep from overrunning the mooring, shut down the engine early and let the seaplane coast to the mooring. If necessary, the engine can be started again for better positioning.

Never straddle a buoy with a twin-float installation. Always approach while keeping the buoy to the outside of the float to avoid damage to the propeller and underside of the fuselage. Initial contact with the buoy is usually made with a boat hook or a person standing on the deck of one float.

While approaching the mooring, have the person on the float secure one end of a short line to the bottom of a float strut, if one is not there already. Then taxi the seaplane right or left of the mooring so that the float on which the person is standing comes directly alongside the buoy. The free end of the line can then be secured to the mooring.

Exercise extreme caution whenever a person is assisting in securing the seaplane. There have been many instances of helpers being struck by the propeller. On

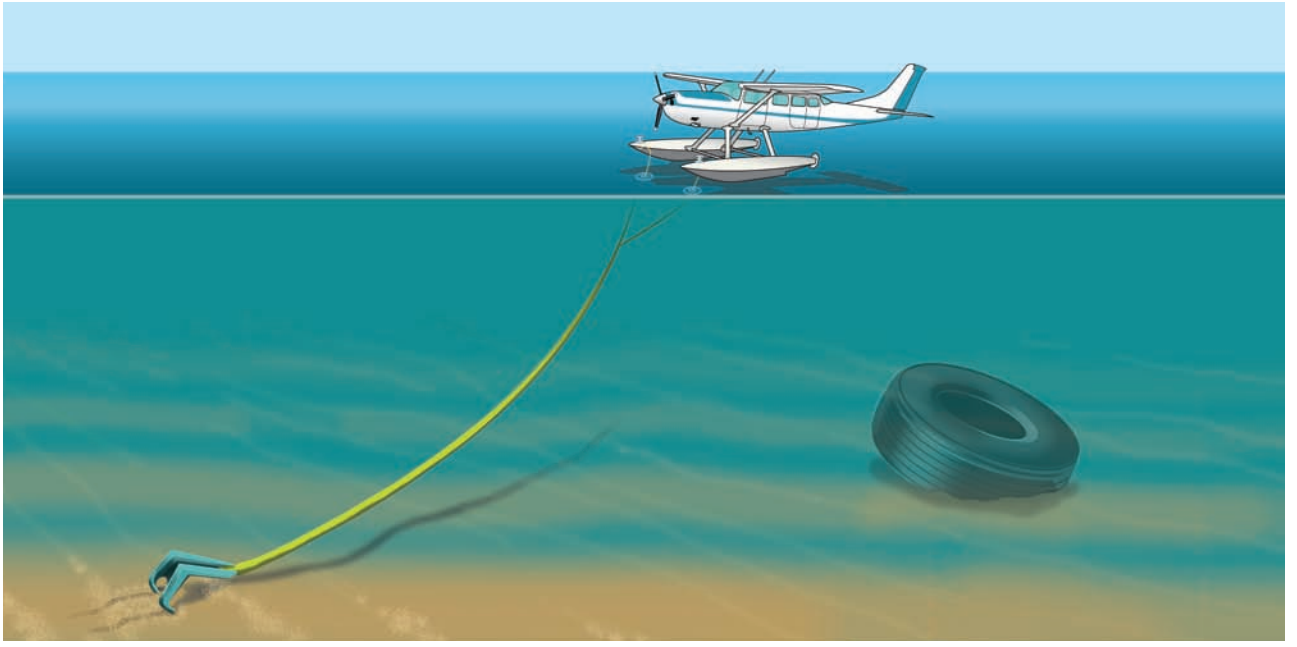


Figure 6-8. Anchoring.

most floatplanes, the floats extend well in front of the propeller arc. Eager to do a good job, an inexperienced helper might forget the spinning propeller while walking forward along the float.

DOCKING

The procedure for docking is essentially the same as for mooring, except that approaching directly into the wind may not be an option. The keys to successful docking are proper planning of the approach to the dock, compensating for the existing environmental conditions, and skill in handling the seaplane in congested areas. Bear in mind that a seaplane is fragile and hitting an obstruction can result in extensive damage.

Plan the approach to the dock so as to keep the wind on the seaplane's nose as much as possible. While still well clear of the dock area, check the responsiveness of the water rudders and be sure the seaplane will be able to maneuver in the existing wind and current. If control seems marginal, turn away and plan an alternative method of reaching the dock. While approaching the dock, the person who will be jumping out to secure the seaplane should take off seatbelts and unlatch the door. When it is clear that the seaplane will just make it to the dock, shut down the engine and let the seaplane coast the remaining distance to encounter the dock as gently as possible. The person securing the seaplane should step out onto the float, pick up the mooring line attached to the rear float strut, and step onto the dock as the seaplane stops. The line should be secured to a mooring cleat on the dock. Use additional mooring lines if the seaplane will be left unattended. Be sure to complete any remaining items on the checklist, and to double-check that the mixture, magnetos, and master switch are in the off positions.

BEACHING

Success in beaching depends primarily on the type and firmness of the shoreline. Inspect the beach carefully before using it. If this is impossible, approach the beach at an oblique angle so the seaplane can be turned out into deeper water if the beach is unsatisfactory. The hardest packed sand is usually near the water's edge and becomes softer where it is dry, further from the water's edge. Rocky shorelines are likely to damage the floats, especially if significant waves are rolling in. Mud bottoms are usually not desirable for beaching.

To protect them from damage, water rudders should be up before entering the shallow water near a beach. Sand is abrasive and erodes any protective coatings on the bottoms of the floats. If possible, beach the seaplane by sailing backward with the water rudders up. The aft bottoms of the floats do not dig into the sand as deeply as the forward bottoms, so backing onto a beach is not as hard on the floats as going in nose-first.

Do not leave the seaplane unattended unless at least a tail line is fastened to some solid object ashore. Moderate action of the water rapidly washes away the sand under the floats and lets the seaplane drift. An incoming tide can float a beached seaplane in just a few minutes. Likewise, a receding tide may leave a seaplane stranded 30 or 40 feet from the water in a few hours. Even small waves may alternately pick up and drop the seaplane, potentially causing serious damage, unless the seaplane is beached well out of their reach. Flying boat pilots should be sure to clear the main gear wells of any sand or debris that may have accumulated before departing.

If the seaplane is beached overnight or higher winds are expected, use portable tiedowns or stakes driven into firm ground and tie it down like a landplane. If severe winds are expected, the compartments of the floats can be filled with water. This holds the seaplane in very high winds, but it is a lot of work to pump out the floats afterward.

RAMPING

For the purpose of this discussion, a ramp is a sloping platform extending well under the surface of the water. If the ramp is wood, the seaplane can be slid up or down it on the keels of the floats, provided the surface of the ramp above the water is wet. Concrete boat ramps are generally not suitable for seaplanes. Water rudders should be down for directional control while approaching the ramp, but raised after the seaplane hits the ramp.

If the wind is blowing directly toward the shore, it is possible to approach the ramp downwind with enough speed to maintain control. Continue this speed until the seaplane actually contacts the ramp and slides up it. Many inexperienced pilots make the mistake of cutting the power before reaching the ramp for fear of hitting it too hard. This is more likely to result in problems, since the seaplane may weathervane and hit the ramp sideways or backward, or at least need to be taxied out for another try. When approaching at the right speed, the bow wave of the float cushions the impact with the ramp, but if the seaplane is too slow or decelerating, the bow wave moves farther back along the float and the impact with the ramp may be harder. Many pilots apply a little power just prior to hitting the ramp, which raises the fronts of the floats and creates more of a cushioning bow wave. Be sure to hold the elevator control all the way back throughout the ramping. [Figure 6-9]

When the seaplane stops moving, shut down the engine and complete the appropriate checklist. Ideally, the seaplane should be far enough up the ramp that waves or swells will not lift the floats and work the seaplane

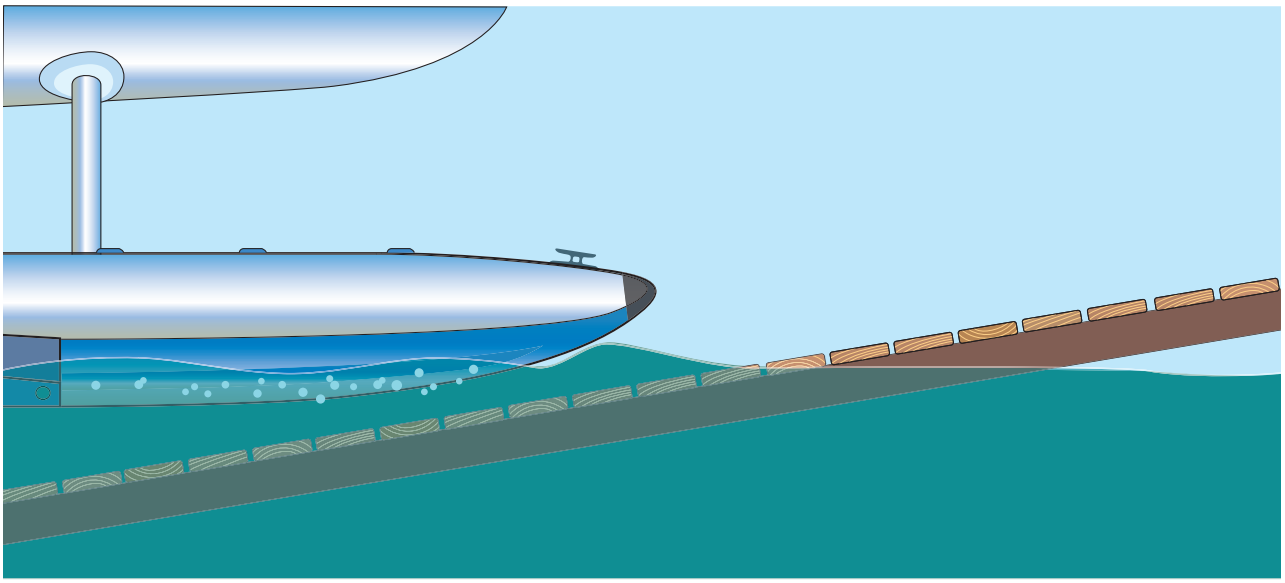


Figure 6-9. The bow wave cushions the contact with the ramp.

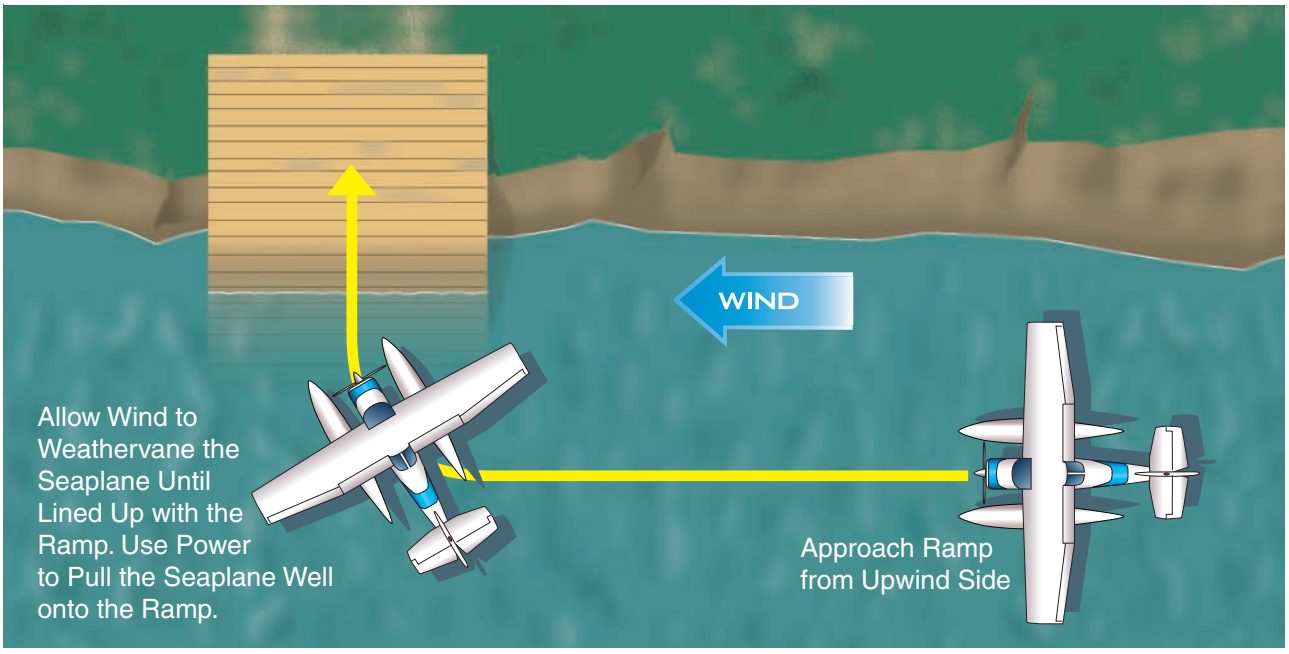

WIND
Allow Wind to Weathervane the Seaplane Until Lined Up with the Ramp. Use Power to Pull the Seaplane Well onto the Ramp.
Approach Ramp from Upwind Side

Figure 6-10. Crosswind approach to a ramp.

back into the water, but not so far up the ramp that shoving off is difficult. Ramps are usually quite slippery, so pilot and passengers must be very cautious of their footing when walking on the ramp.

The most difficult approach is when the wind is blowing parallel to the shore, and strong enough to make control marginal. If the approach is made into the wind, it may not be possible to turn the seaplane crosswind toward the ramp without excessive speed. In most cases, the best procedure is to taxi directly downwind until near the ramp, then close the throttle at the right point to allow weathervaning to place the seaplane on the ramp in the proper position. Then apply power to pull the seaplane up the ramp and clear of the water. This should not be attempted if the winds are high or the ramp is too slippery, since the seaplane could be blown sideways off the leeward side of the ramp. [Figure 6-10]

Experience and proficiency are necessary for ramping in strong winds. In many instances, the safest procedure is to taxi upwind to the ramp and near enough for a helper to attach a line to the floats. The seaplane may then be left floating, or pushed and pulled into a position where a vehicle can haul it up the ramp.

SALT WATER

Any time the seaplane has been operated in salt water, be sure to flush the entire seaplane with plenty of fresh water to minimize corrosion.

Chapter 8

Emergency Open Sea Operations

Operations in Open Seas

Open sea operations are very risky and should be avoided if possible. If an open sea landing cannot be avoided, a thorough reconnaissance and evaluation of the conditions must be performed to ensure safety. The sea usually heaves in a complicated crisscross pattern of swells of various magnitudes, overlaid by whatever chop the wind is producing. A relatively smooth spot may be found where the cross swells are less turbulent. Both a high and a low reconnaissance are necessary for accurate evaluation of the swell systems, winds, and surface conditions.

Definitions

When performing open sea operations, it is important to know and understand some basic ocean terms. A thorough knowledge of these definitions allows the pilot to receive and understand sea condition reports from other aircraft, surface vessels, and weather services.

Fetch—An area where wind is generating waves on the water surface. Also the distance the waves have been driven by the wind blowing in a constant direction without obstruction.

Sea—Waves generated by the existing winds in the area. These wind waves are typically a chaotic mix of heights, periods, and wavelengths. Sometimes the term refers to the condition of the surface resulting from both wind waves and swells.

Swell—Waves that persist outside the fetch or in the absence of the force that generated them. The waves have a uniform and orderly appearance characterized by smooth, regularly spaced wave crests.

Primary Swell—The swell system having the greatest height from trough to crest.

Secondary Swells—Swell systems of less height than the primary swell.

Swell Direction—The direction from which a swell is moving. This direction is not necessarily the result of the wind present at the scene. The swell encountered may be moving into or across the local wind. A swell tends to maintain its original direction for as long as it continues in deep water, regardless of changes in wind direction.

Swell Face—The side of the swell toward the observer. The back is the side away from the observer.

Swell Length—The horizontal distance between successive crests.

Swell Period—The time interval between the passage of two successive crests at the same spot in the water, measured in seconds.

Swell Velocity—The velocity with which the swell advances in relation to a fixed reference point, measured in knots. (There is little movement of water in the horizontal direction. Each water particle transmits energy to its neighbor, resulting primarily in a vertical motion, similar to the motion observed when shaking out a carpet.)

Chop—A roughened condition of the water surface caused by local winds. It is characterized by its irregularity, short distance between crests, and whitecaps.

Downswell—Motion in the same direction the swell is moving.

Upswell—Motion opposite the direction the swell is moving. If the swell is moving from north to south, a seaplane going from south to north is moving upswell.

Sea State Evaluation

Wind is the primary cause of ocean waves and there is a direct relationship between speed of the wind and the state of the sea in the immediate vicinity. Windspeed forecasts can help the pilot anticipate sea conditions. Conversely, the condition of the sea can be useful in determining the speed of the wind. Figure 8-1 on the next page illustrates the **Beaufort wind scale** with the corresponding **sea state condition number**.

While the height of the waves is important, it is often less of a consideration than the wavelength, or the distance between swells. Closely spaced swells can be very violent, and can destroy a seaplane even though the wave height is relatively small. On the other hand, the same seaplane might be able to handle much higher waves if the swells are several thousand feet apart. The relationship between the swell length and the height of

BEAUFORT WIND SCALE WITH CORRESPONDING SEA STATE CODES					
Beaufort Number	Wind Velocity (Knots)	Wind Description	Sea State Description	Sea State	
				Term and Height of Waves (Feet)	Condition Number
0	Less than1	Calm	Sea surface smooth and mirror-like	Calm, glassy 0	0
1	1-3	Light Air	Scaly ripples, no foam crests		
2	4-6	Light Breeze	Small wavelets, crests glassy, no breaking	Calm, rippled 0 – 0.3	1
3	7-10	Gentle Breeze	Large wavelets, crests begin to break, scattered whitecaps	Smooth, wavelets 0.3-1	2
4	11-16	Moderate Breeze	Small waves, becoming longer, numerous whitecaps	Slight 1-4	3
5	17-21	Fresh Breeze	Moderate waves, taking longer form, many whitecaps, some spray	Moderate 4-8	4
6	22-27	Strong Breeze	Larger waves, whitecaps common, more spray	Rough 8-13	5
7	28-33	Near Gale	Sea heaps up, white foam streaks off breakers	Very rough 13-20	6
8	34-40	Gale	Moderately high, waves of greater length, edges of crests begin to break into spindrift, foam blown in streaks		
9	41-47	Strong Gale	High waves, sea begins to roll, dense streaks of foam, spray may reduce visibility		
10	48-55	Storm	Very high waves, with overhanging crests, sea white with densely blown foam, heavy rolling, lowered visibility	High 20-30	7
11	56-63	Violent Storm	Exceptionally high waves, foam patches cover sea, visibility more reduced	Very high 30-45	8
12	64 and over	Hurricane	Air filled with foam, sea completely white with driving spray, visibility greatly reduced	Phenomenal 45 and over	9

Figure 8-1. Beaufort wind scale.

the waves is the **height-to-length ratio** [Figure 8-2]. This ratio is an indication of the amount of motion a seaplane experiences on the water and the threat to capsizing. For example, a body of water with 20-foot waves and a swell length of 400 feet has a height-to-length ratio of 1:20, which may not put the seaplane at risk of capsizing, depending on the crosswinds.

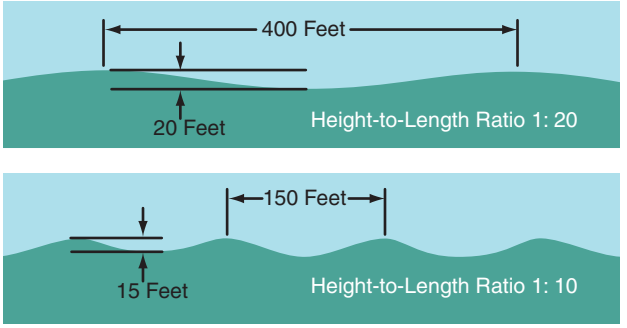


Figure 8-2. Height-to-length ratio.

However, 15-foot waves with a length of 150 feet produce a height-to-length ratio of 1:10, which greatly increases the risk of capsizing, especially if the wave is breaking abeam of the seaplane. As the swell length decreases, swell height becomes increasingly critical to capsizing. Thus, when a high swell height-to-length ratio exists, a crosswind takeoff or landing should not be attempted. Downwind takeoff and landing may be made downswell in light and moderate wind; however, a downwind landing should never be attempted when wind velocities are high regardless of swell direction.

When two swell systems are in phase, the swells act together and result in higher swells. However, when two swell systems are in opposition, the swells tend to cancel each other or "fill in the troughs." This provides a relatively flat area that appears as a lesser concentration of whitecaps and shadows. This flat area is a good touchdown spot for landing. [Figure 8-3]

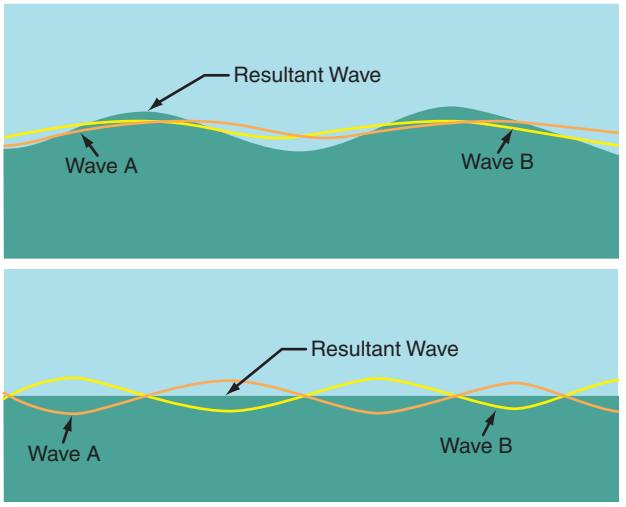


Figure 8-3. Wave interference.

SWELL SYSTEM EVALUATION

The purpose of the swell system evaluation is to determine the surface conditions and the best heading and technique for landing. Perform a high reconnaissance, a low reconnaissance, and then a final determination of landing heading and touchdown area.

HIGH RECONNAISSANCE

During the high reconnaissance, determine the swell period, swell velocity, and swell length. Perform the high reconnaissance at an altitude of 1,500 to 2,000 feet. Fly straight and level while observing the swell systems. Perform the observation through a complete 360º pattern, rolling out approximately every 45º.

Fly parallel to each swell system and note the heading, the direction of movement of the swell, and the direction of the wind.

To determine the time and distance between crests, and their velocity, follow these directions:

1. Drop smoke or a float light and observe the wind condition.
2. Time and count the passage of the smoke or float light over successive crests. The number of waves is the number of crests counted minus one. (A complete wave runs from crest to crest. Since the timing starts with a crest and ends with a crest, there is one less wave than crests.) Time and count each swell system.
3. Obtain the swell period by dividing the time in seconds by the number of waves. For example, 5 waves in 30 seconds equates to a swell period of 6 seconds.
4. Determine the swell velocity in knots by multiplying the swell period by 3. In this example, 6 seconds multiplied by 3 equals 18 knots.
5. To determine the swell length or distance between crests in feet, multiply the square of the swell period by 5. For example, using a 6-second swell period, 6^2 multiplied by 5 equals 180 feet. [Figure 8-4]

Swell Period	$\frac{\text{Time in Seconds}}{\text{Number of Waves Counted}}$
Swell Velocity	Swell Period x 3 knots
Swell Length	Swell Period^2 x 5 Feet

Figure 8-4. Rules of thumb to determine swell period, velocity, and length.

LOW RECONNAISSANCE

Perform the low reconnaissance at 500 feet to confirm the findings of the high reconnaissance and obtain a more accurate estimate of wind direction and velocity.

If the direction of the swell does not agree with the direction noted at 2,000 feet, then there are two swell systems from different directions. The secondary swell system is often moving in the same direction as the wind and may be superimposed on the first swell system. This condition may be indicated by the presence of periodic groups of larger-than-average swells.

The wind direction and speed can be determined by dropping smoke or observing foam patches, whitecaps, and wind streaks. Whitecaps fall forward with the wind but are overrun by the waves. Thus, the foam patches appear to slide backward into the direction from which the wind is blowing. To estimate wind velocity from sea surface indications, see figure 8-1.

SELECT LANDING HEADING

When selecting a landing heading, chart all observed variables and determine the headings that will prove the safest while taking advantage of winds, if possible. Descend to 100 feet and make a final evaluation by flying the various headings and note on which heading the sea appears most favorable. Use the heading that looks smoothest and corresponds with one of the possible headings selected by other criteria.

Consider the position of the sun. A glare on the water during final approach might make that heading an unsafe option.

Use caution in making a decision based on the appearance of the sea. Often a flightpath directly downswell appears to be the smoothest, but a landing on this heading could be disastrous.

SELECT TOUCHDOWN AREA

On final approach, select the touchdown area by searching for a null or smooth area in the swell system, avoiding rough areas if possible. When doing so, consider the conditions discussed in the following sections.

LANDING PARALLEL TO THE SWELL

When landing on a swell system with large, widely spaced crests more than four times the length of the floats, the best landing heading parallels the crests and has the most favorable headwind component. In this situation, it makes little difference whether touchdown is on top of the crest or in the trough.

LANDING PERPENDICULAR TO THE SWELL

If crosswind limits would be exceeded by landing parallel to the swell, landing perpendicular to the swell might be the only option. Landing in closely spaced swells less than four times the length of the floats should be considered an emergency procedure only, since damage or loss of the seaplane can be expected. If the distance between crests is less than half the length of the floats, the touchdown may be smooth, since the floats will always be supported by at least two waves, but expect severe motion and forces as the seaplane slows.

A downswell landing on the back of the swell is preferred. However, strong winds may dictate landing into the swell. To compare landing downswell with landing into the swell, consider the following example. Assuming a 10-second swell period, the length of the swell is 500 feet, and it has a velocity of 30 knots or 50 feet per second. Assume the seaplane takes 890 feet and 5 seconds for its runout.

Downswell Landing—The swell is moving with the seaplane during the landing runout, thereby increasing the effective swell length by about 250 feet and resulting in an effective swell length of 750 feet. If the seaplane touches down just beyond the crest, it finishes its runout about 140 feet beyond the next crest. [Figure 8-5]

Landing into the Swell—During the 5 seconds of runout, the oncoming swell moves toward the seaplane a distance of about 250 feet, thereby shortening the effective swell length to about 250 feet. Since the seaplane takes 890 feet to come to rest, it would meet the oncoming swell less than halfway through its runout and it would probably be thrown into the air, out of control. Avoid this landing heading if at all possible. [Figure 8-6]

If low ceilings prevent complete sea evaluation from the altitudes prescribed above, any open sea landing should be considered a calculated risk, as a dangerous but unobserved swell system may be present in the proposed landing area. Complete the descent and before-landing checklists prior to descending below 1,000 feet if the ceiling is low.

LANDING WITH MORE THAN ONE SWELL SYSTEM

Open water often has two or more swell systems running in different directions, which can present a confusing appearance to the pilot. When the secondary swell system is from the same direction as the wind, the preferred direction of landing is parallel to the primary swell with the secondary swell at some angle. When landing parallel to the primary swell, the two choices of heading are either upwind and into the secondary swell, or downwind and downswell. The heading with the greatest headwind is preferred; however, if a pronounced secondary swell system is present, it may be desirable to land downswell to the secondary swell system and accept some tailwind component. The risks associated with landing downwind versus downswell must be carefully considered. The choice of heading depends on the velocity of the wind versus the velocity and the height of the secondary swell. [Figure 8-7]

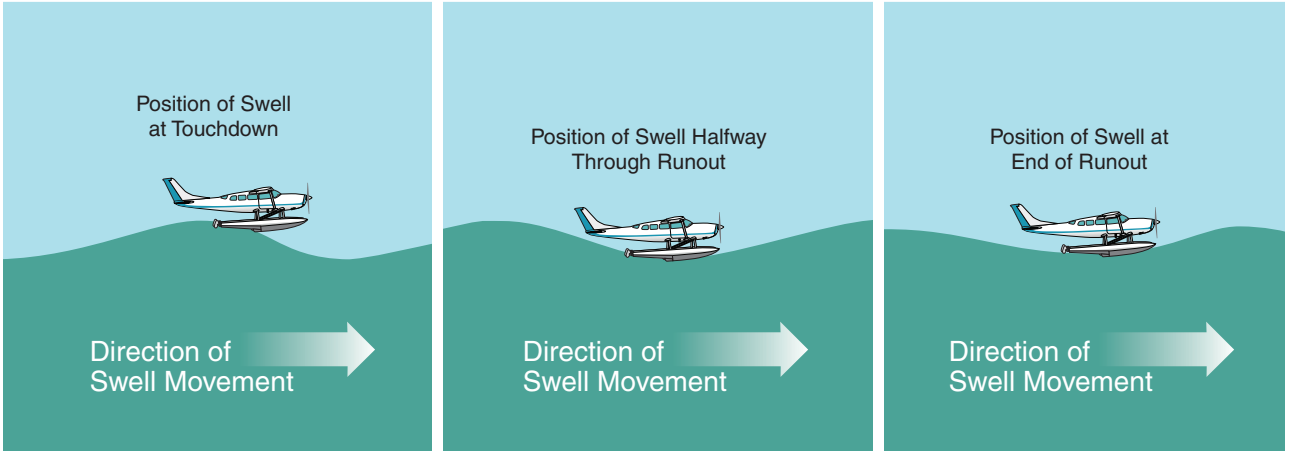

Position of Swell at Touchdown
Direction of Swell Movement
Position of Swell Halfway Through Runout
Direction of Swell Movement
Position of Swell at End of Runout
Direction of Swell Movement

Figure 8-5. Landing in the same direction as the movement of the swell increases the apparent length between swell crests.

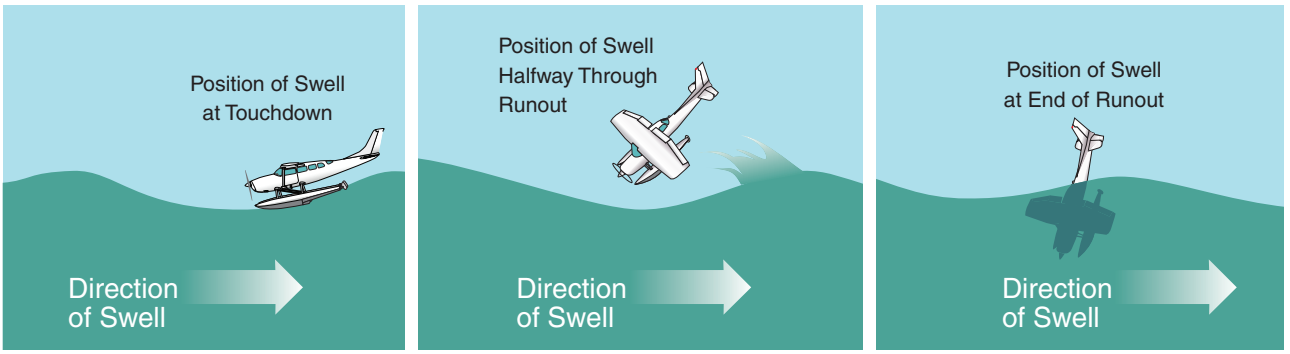


Figure 8-6. Landing against the swell shortens the apparent distance between crests, and could lead to trouble.

Due to the rough sea state, landings should not be attempted in winds greater than 25 knots except in extreme emergencies. Crosswind limitations for each type of seaplane must be the governing factor in crosswind landings.

EFFECT OF CHOP

Chop consists of small waves caused by local winds in excess of 14 knots. These small waves ride on top of the swell system and, if severe, may hide the underlying swell system. Alone, light and moderate chop are not considered dangerous for landings.

NIGHT OPERATIONS

Night landings in seaplanes on open water are extremely dangerous with a high possibility of damage or loss of the seaplane. A night landing should only be performed in an extreme emergency when no other options are available. A night landing on a lighted runway exposes the seaplane to much less risk.

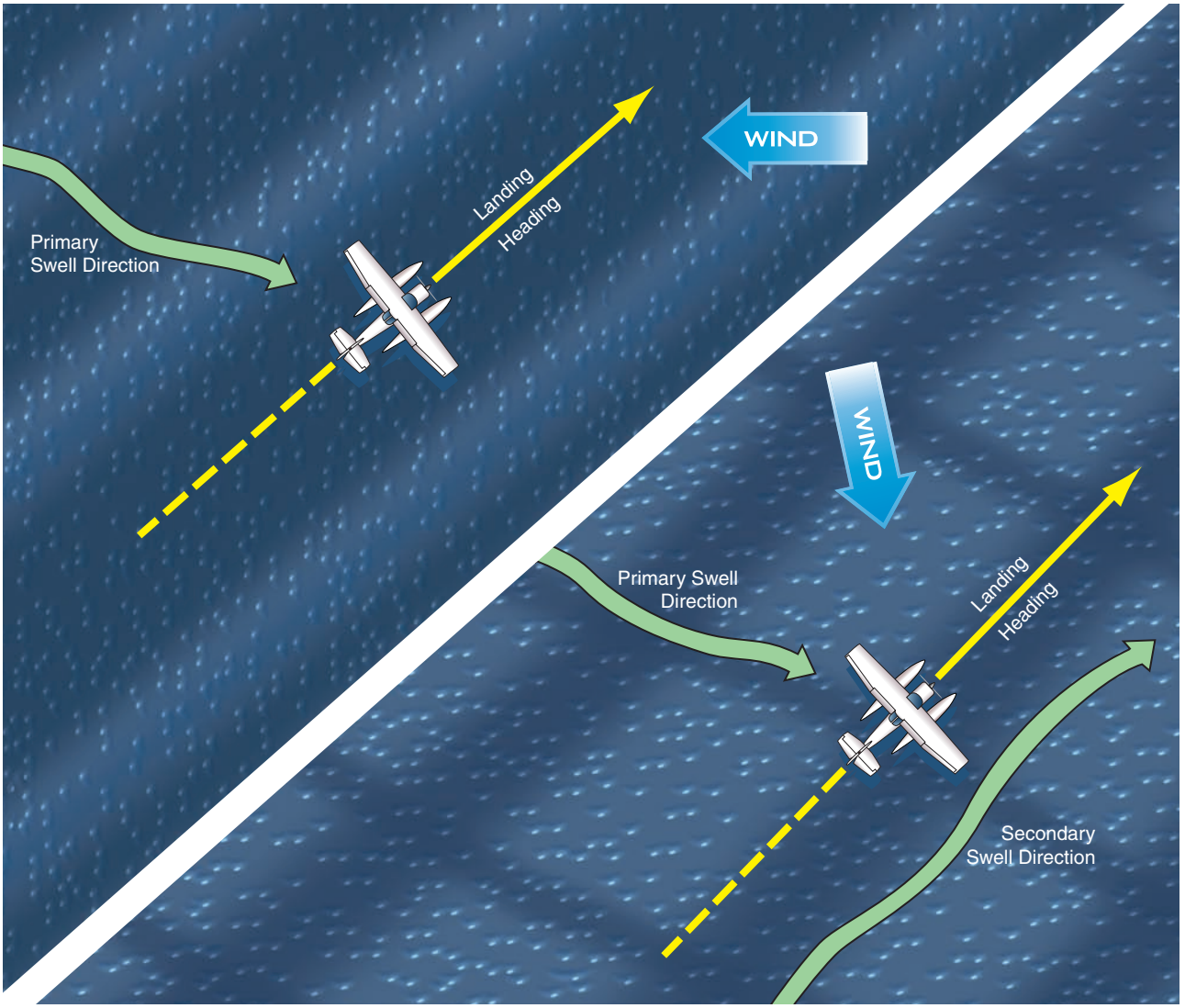


Figure 8-7. Landing heading in single and multiple swell systems.

If operating at night, equip the seaplane with parachute flares, smoke floats, glow sticks, or other markers.

SEA EVALUATION AT NIGHT

Before attempting a night landing, perform a sea state evaluation as described in previous sections. If an emergency occurs shortly after nightfall, a landing heading can be determined by estimating the current conditions from those conditions prevalent before nightfall. If the pilot has no information to form an estimate of the conditions, the information must be obtained from other sources or determined by the pilot from a sea state evaluation by flare illumination or moonlight. If near a ship, sea weather conditions and a recommended landing heading may be obtained from the ship. However, a landing heading based on such information is subject to error and should only be used as a last resort. A pilot evaluation is preferred and can be accomplished by performing the teardrop pattern night sea evaluation as follows:

1. Set a parachute flare and adjust the altitude so that the flare ignites at 1,700 feet. Altitude should be as close to 2,000 feet as possible.
2. After the drop, adjust altitude to 2,000 feet and maintain the heading for 45 seconds.
3. Turn back 220º, left or right, until the flare is almost dead ahead. The sea becomes visible after the first 70º of the turn is completed, allowing approximately 90 seconds for sea evaluation. Use standard rate turn (3º per second).
4. Immediately after passing the flare, if it is still burning, the pilot may circle to make additional evaluation during remaining burning time.

If both pilot and copilot are present, the pilot should fly the seaplane and the copilot should concentrate on the sea evaluation. If only two flares are available and sea conditions are known or believed to be moderate, it may be advisable to dispense with the sea evaluation and use both flares for landing.

NIGHT EMERGENCY LANDING

A night landing should be performed only after exhausting all other options. Be sure all occupants are wearing life vests and secure loose items prior to touchdown. Remove liferafts and survival equipment from their storage containers and give them to those occupants closest to the exits. Prior to the landing pattern, unlatch the doors to prevent jamming that may be caused by airframe distortion from a hard landing. If time permits, make distress calls and activate the emergency locator transmitter.

LANDING BY PARACHUTE FLARE

When a landing heading has been determined and all emergency and cockpit procedures have been accomplished, the landing approach with the use of parachute flares is made as follows:

1. Establish a heading 140º off the selected landing heading.
2. Lower the flaps and establish the desired landing pattern approach speed.
3. As close to 2,000 feet above the surface as possible, set the parachute flare and adjust the altitude so the flare ignites at 1,700 feet.
4. Release the flare and begin a descent of 900 f.p.m. while maintaining heading for 45 seconds. If the starting altitude is other than 2,000 feet, determine the rate of descent by subtracting 200 feet and dividing by two. (For example, 1800 feet minus 200 is 1600, divided by 2 equals an 800 f.p.m. rate of descent).
5. After 45 seconds, make a standard rate turn of 3º per second toward the landing heading in line with the flare. This turn is 220º and takes approximately 73 seconds.
6. Roll out on the landing heading in line with the flare at an altitude of 200 feet. During the last two-thirds of the turn, the water is clearly visible and the seaplane can be controlled by visual reference.
7. Land straight ahead using the light of the flare. Do not overshoot. Overshooting the flare results in a shadow in front of the aircraft making depth perception very difficult. The best touchdown point is several hundred yards short of the flare.

A rapid descent in the early stages of the approach allows a slow rate of descent when near the water. This should prevent flying into the water at a high rate of descent due to faulty depth perception or altimeter setting. [Figure 8-8]

LANDING BY MARKERS

If parachute flares are not available, use a series of lighted markers to establish visual cues for landing. When a landing heading has been determined and all emergency and cockpit procedures are completed, use drift signals or smoke floats and perform the landing approach as follows:

1. Establish a heading on the reciprocal of the landing heading.
2. Drop up to 20 markers at 2 second intervals.
3. Perform a right 90º turn followed immediately by a 270º left turn while descending to 200 feet.
4. Slightly overshoot the turn to the final approach heading to establish a path parallel and slightly to the right of the markers.

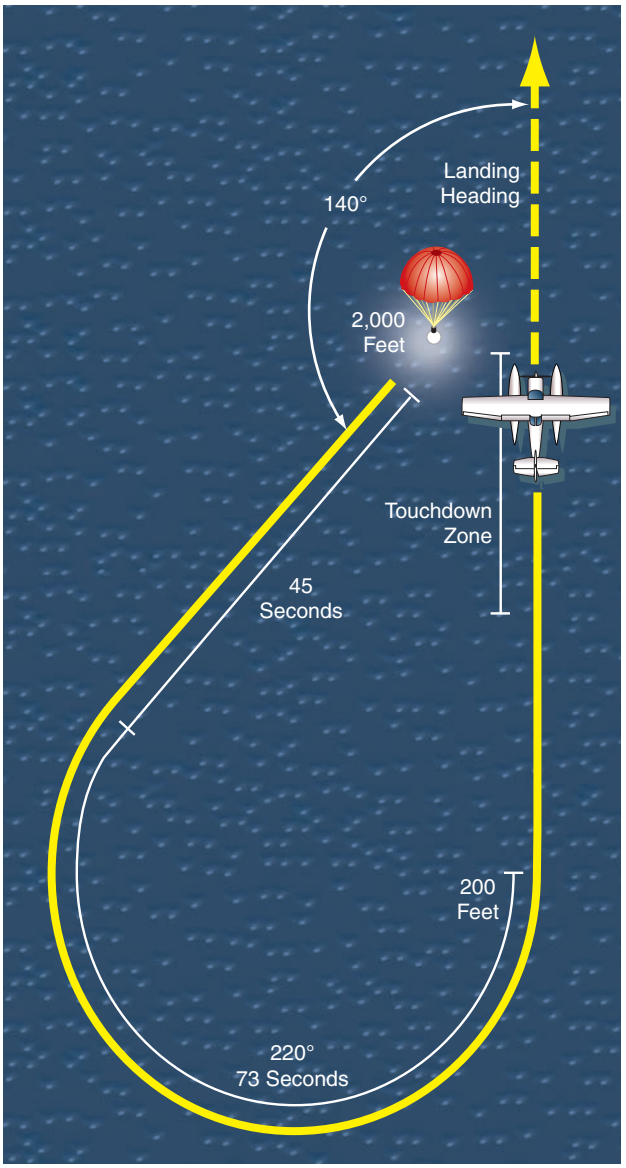


Figure 8-8. Landing by parachute flare.

5. Establish a powered approach with a 200 f.p.m. rate of descent and airspeed 10 percent to 20 percent above stall speed with flaps down, as if for a glassy water landing.
6. Maintain the landing attitude until water contact, and reduce power to idle after touchdown.

Do not use landing lights during the approach unless considerable whitecaps are present. The landing lights may cause a false depth perception. [Figure 8-9]

EMERGENCY LANDING UNDER INSTRUMENT CONDITIONS

When surface visibilities are near zero, the pilot has no alternative but to fly the seaplane onto the water by instruments. A landing heading can be estimated from forecasts prior to departure, broadcast sea conditions, or reports from ships in the area. Obtain the latest local altimeter setting to minimize the possibility of altitude errors during the approach.

Due to the high possibility of damage or capsizing upon landing, be sure all occupants have life vests on and secure all loose items prior to touchdown. Remove liferafts and survival equipment from their storage containers and give them to those occupants closest to the exits. Prior to the landing pattern, unlatch doors to prevent jamming caused by airframe distortion from a hard landing. If time permits, transmit a distress call and activate the emergency locator transmitter.

After choosing a landing heading, establish a final approach with power and set up for a glassy water landing. Establish a rate of descent of 200 f.p.m. and maintain airspeed 10 to 20 percent above stall speed with flaps down. Establish the landing attitude by referring to the instruments. Maintain this approach until the seaplane makes contact with the water, or until visual contact is established.

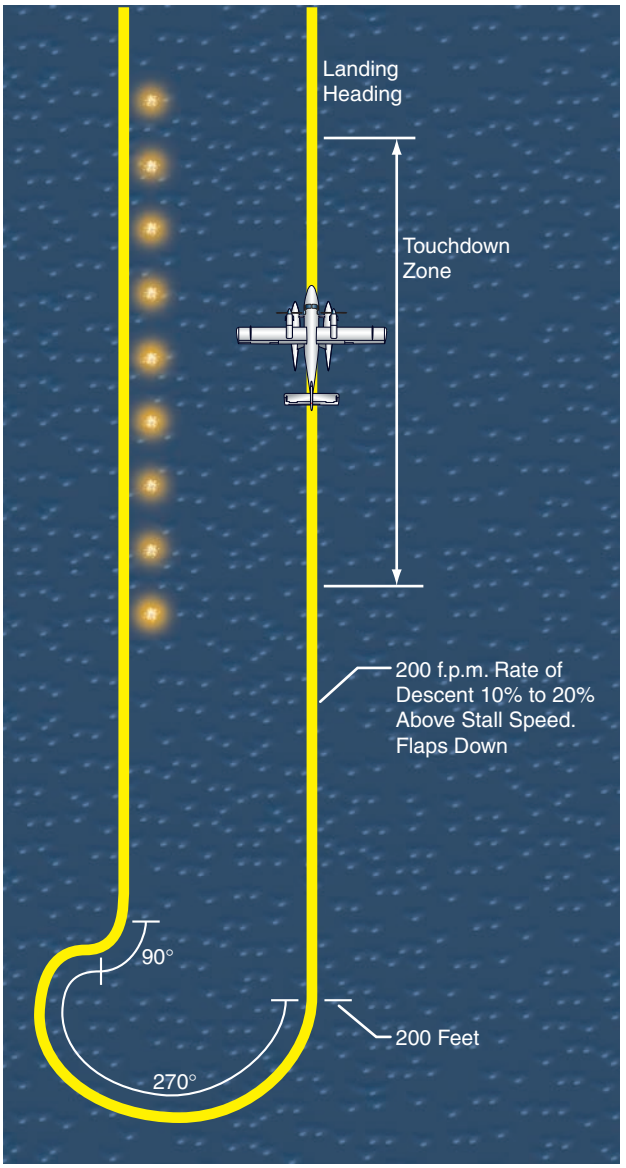


Figure 8-9. Landing by markers.

ESCAPING A SUBMERGED SEAPLANE

If a seaplane capsizes, it is absolutely essential that both pilot and passengers understand how to exit the seaplane and find their way safely to the surface. Pilots should become thoroughly familiar with possible escape scenarios and practice to the extent possible so that they will be able to react instantly in an emergency. Passengers can not be expected to have any prior training in water survival, and an actual emergency is not a good time to try to instruct them. Therefore, a complete briefing before takeoff is very important. At a minimum, the portions of the passenger briefing that deal with escaping from the seaplane in an emergency should cover orientation, water pressure issues, the use of flotation equipment, and both normal and unusual methods of leaving the seaplane.

ORIENTATION

Many of those who have survived seaplane accidents emphasize how disorienting this situation can be. Unlike the clear water of a swimming pool, the water around a seaplane after an accident is usually murky and dark, and may be nearly opaque with suspended silt. In most cases the seaplane is in an unusual attitude, making it difficult for passengers to locate doors or emergency exits. In a number of cases, passengers have drowned while pilots have survived simply because of the pilots' greater familiarity with the inside of the seaplane. Use the preflight briefing to address disorientation by helping passengers orient themselves regardless of the seaplane's attitude. Help the passengers establish a definite frame of reference inside the seaplane, and remind them that even if the cabin is inverted, the doors and exits remain in the same positions relative to their seats. Also, brief passengers on how to find their way to the surface after getting clear of the seaplane. Bubbles always rise toward the surface, so advise passengers to follow the bubbles to get to the surface.

WATER PRESSURE

The pressure of water against the outside of the doors and windows may make them difficult or impossible to open. Passengers must understand that doors and windows that are already underwater may be much easier to open, and that it may be necessary to equalize the pressure on both sides of a door or window before it will open. This means allowing the water level to rise or flooding the cabin adjacent to the door, which can be very counter-intuitive when trapped underwater.

FLOTATION EQUIPMENT

Personal flotation devices (PFDs) are highly recommended for pilots and all passengers on seaplanes. Since the probability of a passenger finding, unwrapping, and putting on a PFD properly during an actual capsizing is rather low, some operators encourage passengers to wear them during the starting, taxiing, takeoff, landing, and docking phases of flight.

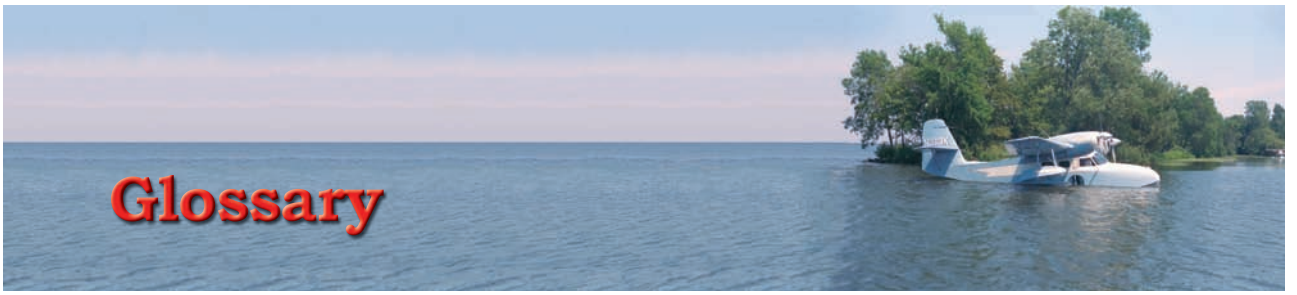
Not all PFDs are appropriate for use in aircraft. Those that do not have to be inflated, and that are bulky and buoyant all the time, can be more of a liability in an emergency, and actually decrease the wearer's chances of survival. Many of the rigid PFDs used for water recreation are not suitable for use in a seaplane. In general, PFDs for aircraft should be inflatable so that they do not keep the user from fitting through small openings or create buoyancy that could prevent the wearer from swimming downward to an exit that is underwater. Obviously, once the wearer is clear of the seaplane, the PFD can be inflated to provide ample support on the water.

The pretakeoff briefing should include instructions and a demonstration of how to put on and adjust the PFD, as well as how to inflate it. It is extremely important to warn passengers never to inflate the PFD inside the seaplane. Doing so could impede their ability to exit, prevent them from swimming down to a submerged exit, risk damage to the PFD that would make it useless, and possibly block the exit of others from the seaplane.

NORMAL AND UNUSUAL EXITS

The briefing should include specifics of operating the cabin doors and emergency exits, keeping in mind that this may need to be done without the benefit of vision. Doors and emergency exits may become jammed due to airframe distortion during an accident, or they may be too hard to open due to water pressure. Passengers should be aware that kicking out a window or the windshield may be the quickest and easiest way to exit the seaplane. Because many seaplanes come to rest in a nose-down position due to the weight of the engine, the baggage compartment door may offer the best path to safety.

In addition to covering these basic areas, be sure to tell passengers to leave everything behind in the event of a mishap except their PFD. Pilots should never assume that they will be able to assist passengers after an accident. They may be injured, unconscious, or impaired, leaving passengers with whatever they remember from the pilot's briefing. A thorough briefing with clear demonstrations can greatly enhance a passenger's chance of survival in the event of a mishap.



Glossary

AMPHIBIAN—A seaplane with retractable wheel-type landing gear that can be extended to allow landings to be made on land.

ANCHOR—A heavy hook connected to the seaplane by a line or cable, intended to dig into the bottom and keep the seaplane from drifting.

AUXILIARY FIN — An additional vertical stabilizer installed on some float planes to offset the increased surface area of the floats in front of the center of gravity.

BEACHING—Pulling a seaplane up onto a suitable shore so that its weight is supported by relatively dry ground rather than water.

BEAUFORT WIND SCALE—A standardized scale ranging from 0-12 correlating the velocity of the wind with predictable surface features of the water.

BILGE—The lowest point inside a float, hull, or watertight compartment.

BILGE PUMP—A pump used to extract water that has leaked into the bilge of a float or flying boat.

BULKHEAD—A structural partition that divides a float or a flying boat hull into separate compartments and provides additional strength.

BUOYANCY—The tendency of a body to float or to rise when submerged in a fluid.

BUOYS—Floating objects moored to the bottom to mark a channel, waterway, or obstruction.

CAN BUOYS— Cylindrical buoys marking the left side of a channel for an inbound vessel. They have odd numbers which increase from seaward.

CAPSIZE—To overturn.

CAST OFF—To release or untie a vessel from its mooring point.

CENTER OF BUOYANCY—The average point of buoyancy in floating objects. Weight added above this point will cause the floating object to sit deeper in the water in a level attitude.

CHINE—The longitudinal seam joining the sides to the bottom of the float. The chines serve a structural purpose, transmitting loads from the bottoms to the sides of the floats. They also serve a hydrodynamic purpose, guiding water away from the float, reducing spray, and contributing to hydrodynamic lift.

CHOP— A roughened condition of the sea surface caused by local winds. It is characterized by its irregularity, short distance between crests, and whitecaps.

COMBINATION SKI— A type of aircraft ski that can be used on snow or ice, but that also allows the use of the skiplane's wheels for landing on runways.

CREST—The top of a wave.

CURRENT — The horizontal movement of a body of water.

DAYBEACONS — Unlighted beacons.

DAYMARKS—Conspicuous markings or shapes that aid in making navigational aids readily visible and easy to identify against daylight viewing backgrounds.

DECK—The top of the float, which can serve as a step or walkway. Bilge pump openings, hand hole covers, and mooring cleats are typically located along the deck.

DISPLACEMENT POSITION—The attitude of the seaplane when its entire weight is supported by the buoyancy of the floats, as it is when at rest or during a slow taxi. Also called the idling position.

DOCK—To secure a seaplane to a permanent structure fixed to the shore. As a noun, the platform or structure to which the seaplane is secured.

DOWNSWELL—Motion in the same direction the swell is moving.

FETCH—An area where wind is generating waves on the water surface. Also the distance the waves have been driven by the wind blowing in a constant direction without obstruction.

FLOATPLANE — A seaplane equipped with separate floats to support the fuselage well above the water surface.

FLOATS—The components of a floatplane's landing gear that provide the buoyancy to keep the airplane afloat.

FLOATS-ON-SKIDS—A type of helicopter float design where the floats sit on top of the fully functional skids. During water operations, the floats support the weight of the aircraft, and on hard surfaces the skids support the weight of the aircraft.

FLYING BOAT—A type of seaplane in which the crew, passengers, and cargo are carried inside a fuselage that is designed to support the seaplane on the water. Also called a hull seaplane.

GLASSY WATER—A calm water surface with no distinguishable surface features, with a glassy or mirror like appearance. Glassy water can deceive a pilot's depth perception.

HEIGHT-TO-LENGTH RATIO—The ratio between the height of a swell to the length between two successive crests (swell length).

HYDRODYNAMIC FORCES—Forces relating to the motion of fluids and the effects of fluids acting on solid bodies in motion relative to them.

HYDRODYNAMIC LIFT—For seaplanes, the upward force generated by the motion of the hull or floats through the water. When the seaplane is at rest on the surface, there is no hydrodynamic lift, but as the seaplane moves faster, hydrodynamic lift begins to support more and more of the seaplane's weight.

IDLING POSITION—The attitude of the seaplane when its entire weight is supported by the buoyancy of the floats, as it is when at rest or during a slow taxi. Also called the displacement position.

KEEL—A strong longitudinal member at the bottom of a float or hull that helps guide the seaplane through the water, and, in the case of floats, supports the weight of the seaplane on land.

LEEWARD—Downwind, or the downwind side of an object.

MOOR—To secure or tie the seaplane to a dock, buoy, or other stationary object on the surface.

NUN BUOYS—Conical buoys marking the left side of a channel for an inbound vessel. They often have even numbers that increase as the vessel progresses from seaward.

PLAIN SKI—A type of aircraft ski that can only be used on snow or ice, as compared to combination skis, which also allow the use of the skiplane's wheels for landing on runways.

PLANING POSITION—The attitude of the seaplane when the entire weight of the aircraft is supported by hydrodynamic and aerodynamic lift, as it is during high-speed taxi or just prior to takeoff. This position produces the least amount of water drag. Also called the step position, or "on the step."

PLOWING POSITION—A nose high, powered taxi characterized by high water drag and an aftward shift of the center of buoyancy. The weight of the seaplane is supported primarily by buoyancy, and partially by hydrodynamic lift.

POP-OUT FLOATS—Helicopter floats that are stored deflated on the skids or in compartments along the lower portion of the helicopter, and deployed in the event of an emergency landing on water. Compressed nitrogen or helium inflates the floats very quickly.

PORPOISING—A rhythmic pitching motion caused by an incorrect planing attitude during takeoff.

PORT—The left side or the direction to the left of a vessel.

PRIMARY SWELL—The swell system having the greatest height from trough to crest.

RAMPING—Using a ramp that extends under the water surface as a means of getting the seaplane out of the water and onto the shore. The seaplane is typically driven under power onto the ramp, and slides partway up the ramp due to inertia and engine thrust.

SAILING—Using the wind as the main motive force while on the water.

SEA—Waves generated by the existing winds in the area. These wind waves are typically a chaotic mix of heights, periods, and wavelengths. Sometimes the term refers to the condition of the surface resulting from both wind waves and swells.

SEA STATE CONDITION NUMBER—A standard scale ranging from 0-9 that indicates the height of waves.

SEAPLANE — An airplane designed to operate from water. Seaplanes are further divided into flying boats and floatplanes.

SEAPLANE LANDING AREA—Any water area designated for the landing of seaplanes.

SEAWARD—The direction away from shore.

SECONDARY SWELLS—Those swell systems of less height than the primary swell.

SISTER KEELSONS—Structural members in the front portion of floats lying parallel to the keel and midway between the keel and chines, adding structural rigidity and adding to directional stability when on the water.

SKEG—A robust extension of the keel behind the step which helps prevent the seaplane from tipping back onto the rear portion of the float.

SKIDS-ON-FLOATS—A type of helicopter float design where the rigid portion of the landing gear rests on the floats. The floats support the whole weight of the helicopter in water or on hard surfaces.

SKIPPING — Successive sharp bounces along the water surface caused by excessive speed or an improper planing attitude when the seaplane is on the step.

SPONSONS—Short, winglike projections from the sides of the hull near the waterline of a flying boat. Their purpose is to stabilize the hull from rolling motion when the flying boat is on the water, and they may also provide some aerodynamic lift in flight. Tip floats also are sometimes known as sponsons.

SPRAY RAILS—Metal flanges attached to the inboard forward portions of the chines to reduce the amount of water spray thrown into the propeller.

STARBOARD—The right side or the direction to the right of a vessel.

STEP—An abrupt break in the longitudinal lines of the float or hull, which reduces water drag and allows the pilot to vary the pitch attitude when running along the water's surface.

STEP POSITION—The attitude of the seaplane when the entire weight of the aircraft is supported by hydrodynamic and aerodynamic lift, as it is during high-speed taxi or just prior to takeoff. This position produces the least amount of water drag. Also called the planing position.

SWELL—Waves that continue after the generating wind has ceased or changed direction. Swells also are generated by ships and boats in the form of wakes, and sometimes by underwater disturbances such as volcanoes or earthquakes. The waves have a uniform and orderly appearance characterized by smooth, rounded, regularly spaced wave crests.

SWELL DIRECTION — The direction from which a swell is moving. Once set in motion, swells tend to maintain their original direction for as long as they continue in deep water, regardless of wind direction. Swells may be moving into or across the local wind.

SWELL FACE—The side of the swell toward the observer. The back is the side away from the observer. These terms apply regardless of the direction of swell movement.

SWELL LENGTH—The horizontal distance between successive crests.

SWELL PERIOD — The time interval between the passage of two successive crests at the same spot in the water, measured in seconds.

SWELL VELOCITY — The velocity with which the swell advances with relation to a fixed reference point, measured in knots. There is little movement of water in the horizontal direction. Each water particle transmits energy to its neighbor, resulting primarily in a vertical motion, similar to the motion observed when shaking out a carpet.

TIDES—The alternate rising and falling of the surface of the ocean and other bodies of water connected with the ocean. They are caused by the gravitational attraction of the sun and moon occurring unequally on different parts of the earth. Tides typically rise and fall twice a day.

TIP FLOATS—Small floats near the wingtips of flying boats or floatplanes with a single main float. The tip floats help stabilize the airplane on the water and prevent the wingtips from contacting the water.

TRANSOM—As it applies to seaplanes, the rear bulkhead of a float.

TROUGH—The low area between two wave crests.

UPSWELL—Motion opposite the direction the swell is moving. If the swell is moving from north to south, a seaplane going from south to north is moving upswell.

VESSEL—Anything capable of being used for transportation on water, including seaplanes.

WATER RUDDERS—
Retractable control surfaces on the back of each float that can be extended downward into the water to provide more directional control when taxiing on the surface. They are attached by cables and springs to the air rudder and operated by the rudder pedals in the cockpit.

WEATHERVANING—The tendency of an aircraft to turn until it points into the wind.

WINDWARD—Upwind, or the upwind side of an object.

WING FLOATS—Stabilizer floats found near the wingtips of flying boats and single main float floatplanes to prevent the wingtips from contacting the water. Also called tip floats.

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